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SCIENCE IN EDUCATION AND INDUSTRY

RECENT discussions on the shortage of science teachers in schools, and also on the parallel shortage of scientific workers, technologists and technical workers in industry, the research associations and Government experimental stations in Great Britain have produced few positive suggestions to meet the situation. Probably the first step required is to complete the man-power survey which the Advisory Council for Scientific Policy initiated when it appointed its Committee on Scientific Man-power in December 1950, and to concert the policy and action, especially in regard to technological education and the shortage of science teachers, to which its report of March 1952 pointed. Here the Lord President of the Council manifestly has both the responsibility and the opportunity for initiative. To him and to the Chancellor of the Exchequer, rather than to the Minister of Education, we might also reasonably look for efforts to influence the choices which are made of careers by boys and girls at the ages of fifteen or sixteen, or even the subsequent choice of university faculties, including the choice of technology rather than science itself. Drive and imagination are required to arouse the interest of young people, and to overcome the lack of awareness or appreciation of the opportunities and importance of both a scientific and a technical education. These qualities are more likely to be found in quarters fully aware of the vital need for scientists and technologists, and the limitations on progress which their absence must place in every sector of the national economy.

Such measures are essential whatever means are adopted for the expansion of technological and technical education. Although an improvement in the supply of science teachers in the schools would help, it is not by itself likely to ensure that there are no places in the existing schools of science, engineering and other technologies unfilled for lack of well-qualified applicants, much more in the expanded schools which are so clearly desirable. Moreover, such measures merge almost imperceptibly into those required for determining the wisest deployment of our scientific and technical man-power, on which the inquiry already suggested could throw further light.

The shortage of science teachers of high quality is in fact only one, though perhaps the most critical and prominent, of our failures to secure the most effective deployment of our scientific man-power. The realization of the threat that this shortage offers to our national welfare should lead to much more drastic and far-reaching action than that contemplated in the report from the National Advisory Council on the Training and Supply of Teachers. It is right and necessary that all possible measures should be taken not only in the schools, but also in the universities, in industry and in Government departments, to see that trained scientists are not employed on duties for which less highly trained men or women are competent, as it is also to see that their services and

advice are not wasted by managements or administrators incapable of assessing scientific and technical factors in a situation. But inquiry should go further into the real reasons for the shortage.

Apart from the economic reasons, the stress which is now being laid on the importance of opportunities for research in schools lends some support to a recent suggestion of Mr. Eric James, High Master of the Manchester Grammar School, that we have invested research with a prestige which is destructively high, since it may be attracting all the ablest scientists from the task of educating the next generation of investigators. Whether or not that view be correct, that it should be advanced suggests caution in dealing with the situation on purely economic grounds. If purely financial proposals could be found which did not involve awkward repercussions, they might still offer no complete solution by themselves. Even diagnosis is as yet incomplete, and meanwhile energetic action along all possible lines to alleviate the situation, including grappling with the thorny question of retirement, is imperative.

Neither that action, nor the working out on the basis of further inquiry of the long-range solution to deal with real causes, can be left to the Minister of Education. Moreover, there is linked with it the whole question of the nature of science teaching in the schools and the use to be made of science graduates as teachers. If more of the graduates in arts, for example, left the universities of Britain with some sound knowledge of general science, they might well be qualified to assist in the general science teaching which is so desirable for the ordinary citizen, whether or not he proceeds beyond the grammar school or technical school level. That in itself, by facilitating the absorption of science into the general culture, should tend to further the supply of promising students for the technical colleges and the university schools of science or technology, and it should also assist the graduate science teachers to concentrate more on the sixth forms or the teaching of those with a scientific career in mind.

No more need be said here to illustrate the complexity of the relations in these questions of training and deploying our scientific and technical manpower, and the imperative need not merely for more precise information but still more for close co-ordination between all the Ministries concerned and between industry, the universities, the technical colleges and the schools. Much more clear thinking is required about the respective functions of these institutions. Although the nature of professional training and the place where it should be given—or at any rate completed—may not be susceptible of a general interpretation, at least ideas could be formulated clearly enough for some agreement to be reached between, say, the universities, the colleges of technology, the research associations, and professional institutions in regard to a particular industry, which would permit expansion being planned on a rational and a national basis. The universities, too, play a decisive part in determining the use made of science teachers in the schools, and a constructive approach from them, as the Advisory Council on the Training and Supply of Teachers obviously recognizes, could have a decisive influence in improving the situation.

Finally, as has already been indicated, the supply of man-power cannot be considered apart from its deployment. The nature of that deployment can markedly affect the resources available for training, as can be seen, for example, in the concern freely expressed by the universities, both in the United Kingdom and in the United States, regarding the sponsoring of research by Government departments. Clearly, the universities would be quite right to set a strict limit to the research enterprises, even in fundamental science, for which they accept responsibility even at Government behest, both because of possible adverse effects on their teaching responsibilities and because the balance of research effort may be seriously distorted. Moreover, while the possibilities in the way of research at the higher technological institutions or of technical colleges have scarcely been explored, there are limits to what is possible here, and the final word must rest with the institutions themselves. A sound judgment would almost certainly be facilitated by the advice and help which the University Grants Committee, or a technological education sub-committee of that body, could give. The complexity of all these relations is sufficient reason for urging once again the importance of placing the responsibility for higher technological education in the hands of the same body that bears the responsibility for the broad supervision of university education.

The question of technical education and of the technical colleges would still remain. While that should no longer be the responsibility of the Ministry of Education or of the local education authorities, it is less clear where the responsibility should be placed. Apart from the educational responsibilities of the research associations, the increasing importance of association of industry with technical education lends support to the view that the Department of Scientific and Industrial Research should be more closely associated with technical education itself. The view which the Advisory Council for Scientific Policy has taken of its responsibilities towards industry and towards education suggests that that body might possibly prove the appropriate authority for watching over the development of the technical colleges in the interests of the nation.

The importance of securing closer association of industry in all these developments can scarcely be over-stressed. It is already fully recognized by the Advisory Council for Scientific Policy, no less than by that for Scientific and Industrial Research, that the effective utilization in industry of existing knowledge, let alone the wider prosecution of industrial research, depends on the presence in industry, and especially at the management-level, of those capable of appreciating the significance of scientific work and the bearing of particular advances on their own industrial activities. This is not simply a matter of education for management: it is a matter of technical and scientific education, of providing industry—and especially the smaller firms—not so much with first-class technologists, as with the larger

numbers of technicians and craftsmen, of men and women trained to a level which enables them to carry out competently the manifold tasks in industry for which a less rigorous training in science and technology is entirely adequate. The problem is not one of producing more scientists or technologists of the very highest class, but of training in science and technology many more of the ordinary school-leavers who could profit by such training though not necessarily to honours degree level.

There is a further reason for welcoming closer association with industry. Developments like these which promote the right balance between technical, technological and university education in the light of the known needs of industry in Great Britain should also foster the spirit of enterprise within industry, without which development may well be sterile. The warning which Sir Henry Tizard gave in his Messel Memorial Lecture on this point needs to be remembered. While the Government is justified in extending the life of the National Research Corporation for a further five years, the latest report of the Corporation gives no clear evidence as to the permanent value of the Corporation in industrial development. At least it can be said it will not be healthy if the existence of the Corporation encourages industry to leave to Government departments judgments and decisions for enterprises in which the initiative properly rests with industry itself. Nor should it be thought that resistance to increased industrial efficiency and productivity comes solely from the management level of industry; for the Labour Party recently attempted to write into the Iron and Steel Bill a provision that no change in the technique or geographical pattern of industry should be allowed if it renders any workers redundant, or downgrades their job or causes them to move to a new locality.

The bearing of technical education, and indeed of the content of general education, on technological change and productivity, so well brought out in the reports issued by the United Nations Educational, Scientific and Cultural Organization, could scarcely be better emphasized. While, therefore, the Government's new policy towards the Department of Scientific and Industrial Research, like the new arrangements for the development of atomic energy, promises substantial benefit to Britain's economy, the realization of that promise depends on wider considerations. It depends in the first place on the Government utilizing the opportunities thus afforded to concert a real policy for scientific and industrial development, and especially for scientific and technical man-power. Of the many facets of that policy, none is at present more important than the handling with vision, with energy and decision, those questions of the supply of science teachers and the balance of technical, technological and university education. Nor will it suffice to secure adequate numbers of scientists, technologists, technicians and craftsmen, managers and administrators capable of identifying the problems to which scientific or technical knowledge can contribute, of assessing the scientific and technical aspects of a situation, and of appreciating the significance of new knowledge. To secure the full and efficient use of such men in industry, Government establishments or public bodies, involves not only eradicating the idea that scientists and technologists must always remain such and be debarred from managerial responsibility; it may well involve also a new outlook and attitude in the Government and in industry at all levels, such as can come not simply by encouraging more people to take up scientific studies, but by a radical change in the content of general education and the teaching of science.

AFRICA SURVEYED

Africa

A Study in Tropical Development. By Prof. L. Dudley Stamp. Pp. vii+568. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 68*s*. net.

PROF. DUDLEY STAMP fears that people "full of enthusiasm but lacking both knowledge and wisdom" will rush in to the salvation of tropical Africa: and so he has attempted, dispassionately and objectively, "to consider its geographical background as an environment for human activity and to study the responses which have been evoked from its African inhabitants and those who, in the last few centuries, have penetrated its fastnesses and molded its fortunes". His special concern has been to emphasize those physical facts of the environment which exercise a permanent and continuing influence and to concentrate more upon major problems than upon local details.

British readers must remember that the book is meant primarily for an American public. This helps to explain not only the high cost of the volume and the excellent range and quality of its 234 illustrations, but also the statement on the dust-cover that "America has a very special interest in Africa" and the fact that as many words are devoted to Liberia as to the larger and more populated territories of Kenya or Uganda.

The volume is divided into three parts: "The Continent"; "The Countries and Regions"; and "Africa Today". Two hundred pages are given to the first section on the whole continent; about three hundred to the regions, of which Prof. Stamp recognizes ten; the final section is but a brief and disappointing chapter incorporating some recent bibliographical and statistical information.

In the first part, Prof. Stamp has conveniently brought together much that is common knowledge about the opening-up of Africa and its human and physical geography, and has illustrated it by a valuable series of maps and diagrams. He has, moreover, incorporated much that is new, notably in the chapters on climates and soils, while in the chapters on pests and diseases and on transportation he has dealt with subjects that in Africa have too often been inadequately considered.

The regional chapters begin with a reminder that "nearly every country in the world has its own individuality". It is expecting much of any writer (even though he be of Prof. Stamp's eminence) to convey in words, diagrams and photographs what a famous French geographer called 'the personality of regions'; the more so in a land-mass as vast and as politically diverse as the continent of Africa. Inevit-

ably a great deal of the information must come from secondary sources and should be acquired and sorted over a longer period than the author has been able to devote to the preparation of this volume. Prof. Stamp is much more convincing when he writes of what he knows at first-hand—Nigeria, for example, or the Union of South Africa—than when he is dealing with certain other areas where the facts seem unrelated and where there is no proper emphasis on the special problems of the moment. In places the juxtaposition of the generalized and the detailed is confusing. In the chapter on East Africa, for example, a general map with relief and place-names (inferior to many atlas maps) and a crude map of population distribution (with 10,000 persons represented by a single dot) are placed alongside reproductions of excellent previously published maps of the topography and vegetation of Mount Kilimanjaro and of types of land occupation in Tanganyika Territory.

Geographers rightly emphasize that their prime concern is with regions as they are: but in a continent the political and economic future of which is of such consequence to the rest of the world, might not more space be devoted to a consideration of some of the prospects of to-morrow? For example, what is Prof. Stamp's assessment of the possibilities of industrial development in the Rhodesias if the water-power of the Kafue river or at the Kariba gorge is harnessed? How will the dams at the Owen Falls in Uganda or on the Volta in the Gold Coast affect the economies and the peoples of East and West Africa, respectively? This book gives no real answer to questions such as these. On the other hand, extended comments are given on development schemes that have proved unsuccessful, notably the East African groundnut scheme, though not everyone will accept all that Prof. Stamp has written about the reasons for its failure. There is, unfortunately, nothing on the geographical and economic background to Central African Federation, nor of the difficulties that geography presents to the proponents of *apartheid* in the Union of South Africa.

But to emphasize such inadequacies and omissions as there are, or to refer to any errors of fact or shortcomings of style that an individual reader may note, would be ungenerous of a fellow-geographer who is impressed by Prof. Stamp's amazing capacity for the condensation and collation of so much information of a highly diverse, and sometimes technical, nature into a reasonable compass. For all its 568 pages, this is a short book compared with other comprehensive volumes on Africa, such as Lord Hailey's "African Survey" (1,837 pages) and the same author's "Native Administration in the British African Territories", the five volumes of which contain nearly 1,400 pages. Prof. Stamp does not claim originality for his latest book: it is essentially a compilation in which attention is very properly directed towards many recent papers in geographical and other periodical literature. For geographers who find it hard to keep afloat in this gathering spate, the book will be invaluable: indeed, for all concerned with Africa, it will become a most useful work of reference. It will do good because it reminds us, as Prof. Stamp puts it, that "throughout much of Africa, especially tropical Africa, the course of man's life is still dictated in large measure by the physical environment". It challenges us all to an investigation of the many problems of Africa to-day on the broadest possible basis, both scientific and political.

R. W. Steel

NATURALLY OCCURRING DERIVATIVES OF NAPHTHALENE

Elsevier's Encyclopædia of Organic Chemistry
Edited by F. Radt. Series 3: Carboisocyclic Compounds. Vol. 12*B*: Naphthalene, A. No. 5: Compounds containing One Naphthalene Nucleus; Naphthoquinones and other Polyketohydronaphthalenes; pp. xxx+2717–3260+Ind. 44; £19. No. 6: Compounds containing One Naphthalene Nucleus, Carboxylic Acids (CO_2H in Side Chain); pp. xlviii+3261–3964+Ind. 78; £24 10*s*.
(Amsterdam and New York: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952–53.)

THE compilation of Vol. 12*B* of this work, dealing with naphthalene and its derivatives, is proving an exceedingly formidable task. Section *A*, comprising compounds containing one naphthalene nucleus, has not yet been completed, although, with the two parts now under review, six parts have been issued, with nearly four thousand pages.

The first of the two parts (No. 5) is concerned largely with the naphthoquinones and their functional derivatives, their homologues, halogen derivatives, nitro-, amino- and azo-derivatives, followed by a large section which describes in detail the hydroxynaphthoquinones and their derivatives. To the natural-product chemist the latter section is the more interesting, dealing as it does with natural pigments including lawsone, juglone, phthiocol, plumbagin, shikonin and alkannin, Hooker's lapachol, and the very remarkable echinochromes and spinochromes. Echinochrome A is said to activate the sperms of sea-urchins in a concentration of 1 in $2{\cdot}5 \times 10^9$, which probably represents the highest dilution in which any form of biological activity has been observed. Physiological properties are described for quite a number of substances listed in both parts of Vol. 12*B*, and in the case of the naphthoquinone derivatives there is frequent reference to their use in analytical chemistry. A ten-page section discusses compounds with vitamin K activity. The reactions of the quinones include many leading to complex heterocyclic structures, which are formulated. 4-Benzyl-1:2-naphthoquinone is one of the few *ortho* quinones which have been used successfully in the Diels–Alder reaction. A few synthetic dyes are described, such as α-naphthol blue, naphthazarin and naphthopurpurin, but the bibliographies contain no reference to patent specifications. Most of the quinones treated are derived from 1:2- or 1:4-naphthoquinone; there is a brief description of 2:6-naphthoquinone, and a short section dealing with diquinones (1:2:3:4- and 1:4:5:8-). Hydronaphthalenes are represented by their few known polycarbonyl derivatives.

The second part (No. 6), in a sense, is not concerned with naphthalene chemistry at all, as it deals with open-chain carboxylic acids which happen to have naphthyl or substituted naphthyl substituents. Associated hydronaphthyl carboxylic acids are also treated. Carboxylic acid derivatives, for example, nitriles and amides, are included although the derived acid may be unknown. Lactones are described, in spite of their heterocyclic character, even if the related hydroxy-acids are unknown. Naphthoic acids and their derivatives will doubtless be dealt with in the next part. The majority of the acids included in the present part are monocarboxylic acids; but brief

sections describe also some di-, tri- and tetra-carboxylic acids. The most important natural product treated is santonin, and the section which describes this lactone and its derivatives and transformation products amounts to more than a hundred pages. Artemisin and alantolactone are dealt with in some detail, and it is a little inconsistent that pseudosantonin is dismissed in a dozen lines. The reason is that its structure was unknown when the material was assembled for this part.

The features with which users of the "Encyclopædia" are already familiar are found again in both parts. There are the usual clear type and excellent printing, the editorial footnotes commenting on ambiguities or wrong assignments of structure (in one case, attention is directed to the fact that the analysis figures do not fit the proposed formula), the elaborate reaction schemes showing the interrelationships of complex natural products (for example, juglone, lapachol, santonin and artemisin), and the inclusion of completely up-to-date references to important papers giving structural information. There is comprehensive literature-cover up to 1944. A useful feature is the indexing under specific headings of anthelmintic and growth-promoting compounds (for example, 1-naphthylacetic acid) and natural products.

The high standard of production has been well maintained, and organic chemists will be grateful to the Elsevier editorial staff for this further contribution to the bibliography of organic chemistry.

J. W. Cook

NUCLEAR PULSE AMPLIFIERS

Signal, Noise and Resolution in Nuclear Counter Amplifiers

By A. B. Gillespie. (Electronics and Waves Series.) Pp. xii+155. (London: Pergamon Press, Ltd., 1953.) 21*s*.

As its title implies, this book does not attempt to deal exhaustively with the design of amplifiers for use with nuclear counters, but restricts itself to some important features in which such amplifiers differ from those used in other applications. These differences arise mainly from the fact that a nuclear counter amplifier receives its input signal in the form of a charge and delivers a pulse of which the peak amplitude must be linearly related to the magnitude of this charge, but the shape is of little interest.

In practice the shape and duration of the output pulse is determined almost entirely by the amplifier constants and scarcely at all by the input signal. The signals usually occur at random times, so that it is not possible to resort to some of the methods for improving the signal-to-noise ratio which are employed in the radar field.

After a brief introduction, the author discusses, in elementary fashion, the nature of the signal produced by an ionization chamber and the relation between this and the amplifier time-constants. The next section discusses the various sources of noise in the amplifier and how these depend on circuit design and valve-operating conditions. This is followed by a detailed discussion of signal-to-noise ratio and how this is influenced by the amplifier parameters. The important point is made that usually a compromise must be sought between signal-to-noise ratio and time resolution. Thus, in comparing the signal-to-noise ratios provided by different systems, the results will be misleading unless the time resolution of these systems is also taken into account. This has not been appreciated by some earlier writers. The next section shows how amplifier noise affects the accuracy of counting experiments. Finally, proportional counters and scintillation counters are considered. In these cases amplifier noise is seldom a problem; but similar effects may be produced by a background of unwanted radiation reaching the counter. Theoretical treatment of this presents difficulties which the author has not been completely successful in overcoming, but useful data are presented.

There is a danger that a book of this nature may become excessively mathematical. This has been successfully avoided by the author, who banishes most of the mathematics to the appendix and relies on physical arguments supported where necessary by theoretical and experimental results. As a result, the text is lucid and easy to read, though one or two grammatical lapses can be detected.

One may question the author's wisdom in taking into account at the outset the finite time of rise of the ionization-chamber pulse. This leads to rather complex expressions in the early part of the book. It might have been simpler initially to assume a step-function input signal and to have derived expressions for signal-to-noise ratio on this basis. It would then not be difficult to show how these results are modified in cases where the pulse-rise time is not short compared with the amplifier time-constants.

Because of its mathematical and practical simplicity, the author has given most consideration to the case where the upper and lower limits of the amplifier pass-band are determined by single resistance-capacity time-constants having values T_2 and T_1 respectively. He rightly concludes that for best results $T_1 = T_2$. These calculations assume that all the other time-constants limiting the high-frequency response of the amplifier are short compared with T_2, and it might be inferred that this is a necessary condition for best signal-to-noise ratio. This is not the case, for it can be shown that if the upper-frequency limit is determined by many time-constants all equal to T_2, the signal-to-noise ratio for a given resolution time, far from being worse, is actually slightly improved. Thus, in an amplifier in which T_1 and T_2 are made adjustable, the most economical design is one in which the high-frequency time-constants of all the stages are equal to the smallest desired value of T_2.

The deliberately limited scope of the book excludes a good deal of information which would be of value to the designer of nuclear counter amplifiers, such as the choice of the most suitable type of negative-feedback circuit and its design to give stable gain with a monotonic step-function response while making best use of the gain band-width properties of available valves. The reaction of pulse amplifiers to large overload pulses is also of importance. While a fair amount has already been written on these subjects, the last word has yet to be said.

Within its scope, however, the book is an excellent one and contains many theoretical and experimental results which have not previously been published. The agreement shown between theory and practice is, in most cases, remarkable. This is a tribute not only to the author's theoretical analysis, but also

to the skill and care with which the experimental measurements of noise must have been made. To obtain reproducible results from such measurements, especially at low frequencies, is something of an achievement.

The designer of nuclear pulse amplifiers will find the book valuable, if he accepts the fact that the problems considered are by no means the only ones he will encounter. The book will also be helpful to nuclear physicists and others who may have to undertake experiments the success or accuracy of which is threatened by the presence of noise or background radiation.

E. H. Cooke-Yarborough

HISTORY OF SCIENCE

A History of the Sciences

Main Currents of Scientific Thought. By Dr. S. F. Mason. Pp. viii+520. (London: Routledge and Kegan Paul, Ltd., 1953.) 28*s*. net.

No one can to-day lament a deficiency of general histories of science. Dr. Charles Singer's "Short History" and Sir William Dampier's "History" were early efforts in this field, of which new editions are still in demand. Dr. W. P. D. Wightman's "Growth of Scientific Thought" is a more recent endeavour to cover similar ground, and now there is this fresh survey from Dr. S. F. Mason, of Oxford, which extends from the ancient empires to Lysenko. This is longer, and more complete in factual detail (especially for the modern period), than any of its predecessors, and on many points the structure of the book shows, very properly, the influence of important modern investigations. The indebtedness of Hellenistic science to its precursors among the Egyptians and Babylonians, as well as among the pre-Socratic Greeks, is well brought out. China and India form the subject of separate chapters in which their contributions to the West are analysed. These are important accessions to a general history of science; but they are not without corresponding losses, since Islam is dismissed in six and a half pages, and medieval Europe in sixteen. Dr. Mason then devotes about two hundred and ten pages to the period 1500–1800, in which the extent to which the 'mechanical philosophy' permeated scientific thought is rightly emphasized, and slightly less space to the nineteenth and twentieth centuries. The main criticism of this balance of the attention given to the main stages of scientific development concerns the very recent period, for here Dr. Mason might be judged to linger excessively on topics which have been dealt with already in a multitude of publications.

On other points, however, Dr. Mason adopts a more conservative attitude. It is a little surprising to be told that Aristotle's zoological works are of later date than his physical (p. 31); that "medieval craftsmen contributed the experimental criterion to the scientific method" (p. 95); that Boyle "gave the modern definition of a chemical element" (p. 190); and that "When natural philosophy began to show signs of stagnation towards the end of the seventeenth century the nascent science of chemistry suffered a serious reverse" (p. 241). On this last question especially, the complete omission of the fundamental work of Mme. Metzger from the bibliography is surely significant. But generally the author proves himself well acquainted with the present flood of research on the history of science—though he lists few non-English publications.

This has helped him to build up a detailed story, especially from the sixteenth century onwards—that is, about four-fifths of the volume. He has assembled a much greater wealth of information on many subjects (for example, science and religion at the time of the Reformation; embryology; and the cell-theory) than is available in any comparable book. To have done so is probably its highest merit, and it is regrettable that the entire lack of illustration must render some of the material unintelligible to readers to whom such matters are unfamiliar. Illustrations would inevitably have increased a very moderate price; but they are ill spared. History, however, is not simply information; the facts must be interpreted. A single theme runs through Dr. Mason's book—that modern science is the product of the combination of a craft and a philosophic tradition with regard to the study of Nature—and it seems that he regards the former as the more important. Thus, he says, the Michurin school of Soviet biologists, of whom Lysenko is the contemporary leader, arose from the work of a practical plant-breeder, while Mendelian genetics sprang from problems in the theory of biology and is largely an academic subject. This he regards as another example of the "difference in outlook between the craft and the scholarly traditions, which has existed throughout written history". The remark may be true, but scarcely in the sense that Dr. Mason intends. Nevertheless, his theme is an important one, for the instruments and experimentation of science have often depended on the resources of craftsmanship, and, more than this, the practical and pragmatic outlook of the craftsman has reinforced on occasion the analytical mind of the philosopher. Yet it is not enough to suppose that this is the whole of science, or that its history is solely concerned with tracing how the latter has successively given place to the former. It is therefore unfortunate that Dr. Mason has not given a fuller account of the way in which he supposes the 'craft' and 'philosophic' traditions to have interacted to yield science, which is so clearly distinct from either. At least in some instances this seems to lead to doubtful propositions, as when he remarks that "a barber-surgeon . . . might be a skilled sectionist and know intimately the anatomical structure of the human body". For while it may be convenient to his thesis to distinguish between this 'craftsman' and the academic Galenist, it is a mere supposition that the barber-surgeon was the better informed of the two.

It would be possible to point to a number of inaccuracies (John Ray's views on fossils are misrepresented on p. 319, perhaps because the author had not consulted Dr. C. E. Raven's authoritative study of Ray) which are inevitable in a work of this scope, even though it can no longer claim to be pioneering. One might ask more seriously: For whom is this book intended? It is not a monograph for the professional historian, nor is it really suitable for the general reader. If it is intended for the cultural education of scientists, it is open to the charge of taking a narrow, and perhaps not very subtle, view of the origins of their studies. May one mildly express the hope that the time has now arrived when it is no longer necessary for every historian of science to take the whole of it for his province?

A. R. Hall

Properties of Matter

By Dr. F. C. Champion and Dr. N. Davy. (Student's Physics, Vol. 3.) Second edition. Pp. xiv+328. (London and Glasgow: Blackie and Son, Ltd., 1952.) 27*s*. 6*d*. net.

FOR schools of physics which teach properties of matter at third-year honours level, this work should make an admirable text-book. It covers the usual subjects, such as gravitation, elasticity, surface tension, osmotic pressure and viscosity, and, in addition, it has chapters on the compressibility of liquids and solids and on seismic waves, which give the student a clear idea of the practical importance of general principles. The various subjects are treated extremely competently, and the physical approach is not subjugated to the mathematical, as so often happens with advanced text-books.

To the reviewer, the only jarring note occurs on the last page of the book, in a chapter on errors of measurement; this chapter discusses the various theoretical considerations involved in assessing the probable error of a quantitative result, and illustrates them by the steps involved in the determination of e and h. The result given for e in 1932 is $(4{\cdot}7787 \pm 0{\cdot}0052) \times 10^{-10}$ e.s.u. The authors then state, without comment, that the value computed in 1941 was $(4{\cdot}8025 \pm 0{\cdot}0011) \times 10^{-10}$ e.s.u. Is this not likely to produce in the student a sense of scepticism about the whole of the theory of errors? Surely the authors should have taken the opportunity of stressing the importance of applying the theory only when systematic errors have been eliminated.

Mass Spectroscopy in Physics Research

Proceedings of the NBS Semicentennial Symposium on Mass Spectroscopy in Physics Research, held at the NBS on September 6, 7 and 8, 1951. (United States Department of Commerce: National Bureau of Standards, Circular 522.) Pp. vi+273. (Washington, D.C.: Government Printing Office, 1953.) 1.75 dollars.

THIS book is a record of the proceedings of a symposium on "Mass Spectroscopy in Physics Research", sponsored by the National Bureau of Standards and held in Washington, D.C., during September 6–8, 1951. The thirty-five papers submitted at the conference together with the discussion ensuing from each paper are given in full, and the book ends with a comprehensive account of an informal discussion on experimental methods. A good knowledge of existing mass-spectroscopy techniques is essential in order properly to appreciate the papers.

An excellent opening paper by J. Mattauch summarizes the field of high-resolution mass spectroscopy with application to the measurement of absolute masses. This is followed by a number of shorter papers by some of the leading physicists in the field of mass measurement describing instruments, the results obtained and possible improvements to the existing equipments. A number of instruments using new techniques for mass measurement are described, for example, time of flight and cyclotron resonance. Isotope abundance measurements are briefly summarized, and techniques are described for some specific problems on the variations in the abundances of naturally occurring isotopes. Two large-scale mass spectrometers are described which have been used successfully for separating very small quantities of pure isotopes for nuclear physics research. The last group of papers deals with a number of specialized subjects which serve to illustrate the wide field of application of mass spectroscopy in modern physics research. In the concluding section, on experimental methods, the use of the electron multiplier as a detector of positive ions is discussed together with the current ideas on high-vacuum gasket materials, ion-source plate spacers, etc. The omission of any papers on the analysis of solid materials by the mass spectrometer is a criticism of the conference rather than of the book.

The book is a valuable acquisition for any laboratory interested in the problem of mass measurement, and it indicates the extensive part played by mass spectroscopy in physics and chemistry research.

G. H. PALMER

New Pathways to Piano Technique

A Study of the Relations between Mind and Body with Special Reference to Piano Playing. By Luigi Bonpensiere. Pp. xxiii+128. (New York: Philosophical Library, Inc., 1953.) 4.75 dollars.

THIS book has been posthumously compiled from notebooks left by Mr. Luigi Bonpensiere. In it is developed a theory of 'ideo-kinetics' based on the author's private experiments. These purport to show that with proper training we can achieve far greater control over our bodily movements and much more rapid acquisition of complex skills than is possible by means of our usual methods of 'physio-kinetics'. In 'ideo-kinetics' the limbs to be used (for example, the hands in piano-playing) are completely disregarded and instead the person concentrates intensely on the image of the goal to be reached.

Mr. Bonpensiere was first trained as a technologist; but his claim to distinction lies in his contribution to art and musicology. Unencumbered by academic lore, he later turned his original mind to empirical problems of body–mind relations and carried out experiments which, if confirmed, may lead to remarkable conclusions. The material is unfortunately fragmentary and expressed in a strange terminology; but the reader willing to overcome these obstacles will find much in it which deserves close study. Although Mr. Bonpensiere illustrates the applications of his theory from piano-playing, the theory applies to every form of bodily skill.

Mr. Aldous Huxley contributes a vivacious and sympathetic preface, and his description of the author as "remarkably gifted" seems to be perfectly just.

JOHN COHEN

The Year's Work in Librarianship

Edited by W. A. Munford. Vol. 15, 1948; pp. x+281. Vol. 16, 1949; pp. x+230. (London: Library Association, 1952.) 40*s*. each vol.; to members, 30*s*.

THE annual publication "The Year's Work in Librarianship" consists of a series of chapters by different authors, those dealing with national and university libraries, with special libraries, with library co-operation, with professional education and with subject bibliography containing most of the information of interest to the man of science as such. They are comprehensive and competent pieces of workmanship, factual rather than critical, but of more worth to the librarian than to his clients. The time-lag in publication seems excessive for a publication of this kind: Vol. 15, covering 1948, appeared in the spring of 1952, and Vol. 16, for 1949, at the end of 1952. Revue publiée Fel 1952 !

BRITISH COLONIAL RESEARCH

REPORT FOR 1952–53

RESEARCH undertaken by government agencies in the British Colonies is described in annual reports under the general title of "Colonial Research". That for 1952–53* follows the pattern of the past two years. It commences with the report of the Colonial Research Council, which this year is slightly longer, and to which is appended a list of schemes approved for research grants, April 1, 1952–March 31, 1952, and the report of the Director of the Colonial Products Advisory Bureau for 1951–52. Following this are the reports of the specialist councils and committees: the tenth annual report of the Colonial Products Research Council, the ninth annual report of the Colonial Social Science Research Council, the eighth annual reports of the Colonial Medical Research Committee and the Committee for Colonial Agriculture, Animal Health and Forestry Research, the sixth annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and the Colonial Economic Research Committee, and the reports for 1952–53 of the Tsetse Fly and Trypanosomiasis Committee, of the Colonial Fisheries Advisory Committee on Fisheries Research and of the Director of the Anti-Locust Research Centre.

The fifty-six new research schemes and fifty-four supplementary schemes made during the year, involving grants totalling £1,087,041, brought the net expenditure and commitment from Colonial Development and Welfare funds since 1940 to about £11 millions at March 31, 1953, while Colonial Governments or industry have provided a further £3 millions. Of the gross allocation, 32·8 per cent has been for agricultural, animal health and forestry schemes, 14·2 per cent for medical research, 12·9 per cent for fisheries research, 10·6 per cent for tsetse and trypanosomiasis research, 9 per cent for social science and economic research, 7·5 per cent for insecticides research, 5·1 per cent for research sponsored by the Colonial Products Research Council and 3·4 per cent for anti-locust research. Under the assistance provided by the United States Mutual Security Agency, Prof. J. C. Matthysse, of Cornell University, completed his investigation in Northern Rhodesia into the control of the tick vectors of protozoal diseases affecting livestock in Africa, and Prof. M. Stelly, University of Georgia, is undertaking in Kenya an investigation into problems of soil fertility, while two United States scientists are to investigate in West and Central Africa pasture production and management and the nutritive qualities of species of grass and other local feeding stuffs.

During October 23, 1952–March 20, 1953, Mr. G. A. Atkinson, who is now housing adviser to the Colonial Office, as well as Colonial liaison officer, Building Research Station, made an extensive tour of East Africa, India and Malaya, as well as visiting Mauritius and attending an African regional housing research conference in Pretoria, organized by the Commission for Technical Co-operation in Africa South of the Sahara. The discussions at this conference indicated that plans for the extension of building research in British West Africa, French African territories and the Belgian Congo are under way, and problems on which further co-operation is desirable were specified: these include the documentation of existing standards of housing, studies of the design of dwellings in relation to climate, a general study of rural housing problems, and studies on sanitation, and on building in earth and earth admixtures. Interest in the use in the tropics of prefabricated systems of house construction, exported from the United Kingdom, has been stimulated by a display of designs at the Housing Centre, London, and, afterwards, by the exhibition of demonstration houses at the British Industries Fair, 1953, while earlier investigations of the Building Research Station for the Uganda Government on raw materials for cement manufacture promise to initiate a series of industries in Uganda which may transform the economy of the Protectorate.

Recruitment of field-staff for geodetic and topographic surveys failed to keep pace with resignations or transfers; but prospects for recruitment of field-surveyors and other technical staff are now much better and an increase of more than fifty in the total staff during 1953–54 is anticipated. The priority area for photo control has been the Volta River area, where a survey by a party of six Directorate surveyors and an average of twelve Gold Coast African surveyors is approaching completion. A party which has completed control in the Western Concession in Northern Rhodesia is proceeding to control mapping for the Kafue Gorge hydroelectric scheme. Changing priorities and the impact of National Service on the cartographic staff have adversely affected map production. With the appointment of seventeen additional geologists and chemists, the overseas scientific staff of the Colonial Geological Surveys numbered 190 on December 31, 1952, and each year shows an increase in effectiveness as the young officers appointed during the past five years grow in experience and confidence. In Northern Rhodesia a new carbonatite occurrence was being examined, and detailed geological mapping was in progress in parts of the Mumbwa district, where copper–gold mineralization is known. In Nigeria several million tons of easily worked coal have been located near the colliery at Enugu, and much geological work has been carried on in other coal areas. Geological mapping has been resumed in some States of the Federation of Malaya, while interest in the mineral deposits of Jamaica has been aroused by the investigations of its Geological Survey Department. Appreciation is again expressed of the practical interest of British universities in the geology and mineral resources of the Colonial territories.

In Singapore some investigations by means of electro-osmosis have been made into the drainage of Singapore Harbour; in addition, the cathodic protection of mild-steel harbour craft by the use of zinc and aluminium anodes, and the use of the North Dakota cone penetrometer in evaluating the stability of road beds and determining economical thickness of road material for a given density of traffic have also been subjects of study. The general shortage of

* Colonial Office. Colonial Research 1952–1953. Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agriculture, Animal Health and Forestry Research, Colonial Insecticides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director, Anti-Locust Research Centre. Pp. 268. (Cmd. 8971.) (London: H.M.S.O., 1953.) 7s. 6d. net.

qualified meteorologists has hindered the filling of staff vacancies, particularly in West Africa and the British Caribbean area, but the Hong Kong Royal Observatory has published papers on the upper flow structure near typhoons and the general circulation of the atmosphere over South-East Asia and the Western Pacific and an analysis of forecasting of the summer weather of the region, besides continuing investigations into the effect of strong winds on rain-gauge accuracy and ionosphere–weather relationship. Seven bases of the Falkland Islands Dependencies Survey were manned throughout the year, while at Signey Island in the South Orkneys the reproductive cycle of the Weddell seal was studied.

All the work of the National Institute of Oceanography, except the care and superintendence of the Discovery Collections, is now centred in its new building at Witley, near Godalming. A main object of its laboratory work is to improve our understanding of marine physics and of the environmental conditions and biological factors which determine the concentrations and fluctuations observed in oceanic fisheries. The marine physicists have concentrated on the problems of sea–air energy exchange and its relation to the large- and small-scale water movements, while much of the effort in marine biology bears on the problems of the life-history, distribution and migration of whales. Studies of the factors which make some parts of the deep ocean more productive than others have centred around recent and earlier surveys of the regions influenced by the Benguela and Peru currents. Work on Colonial problems at the Road Research Laboratory has been limited by shortage of staff; but a report has been issued on the stabilization of a black cotton soil from Southern Rhodesia with lime and wood tar, and recommendations have been made for the use in concrete of four sands and aggregates from North Borneo.

The Colonial Products Advisory Bureau completed seventy-seven laboratory investigations and dealt with 763 inquiries. The more important of these mentioned in the Director's report for 1952–53 are: the collaborative investigations on the biological activity of extracts and the storage performance of flowers of three strains of Kenya pyrethrum, which have indicated that one strain having a high pyrethrin content loses about 25 per cent of its original active content during three months of storage; the preliminary examination of essential oils obtained by steam distillation of sage leaves collected from thirteen localities in Cyprus during April and June–September 1951; the examination of samples of *Cinnamomum parthenoxylon* oil from Sarawak as a source of safrole, required for the synthesis of piperonyl butoxide; the examination as paper-making materials of timbers from twenty-eight species of trees, from Kenya, Malaya and the Gold Coast; and the trials in the Sudan on the drying of goat and sheepskins, which have shown that suspension drying in the sun, without salting, is more satisfactory than dry-salting, subject to a limiting temperature. Further examination of jute and possible jute substitutes has confirmed that, for the finer counts of yarn, jute is in a class on its own, but with further experience it is probable that retting could be carried out satisfactorily in Colonial countries. The work on the identification of fibres has already proved its value, and continued attention was given to a survey of Colonial materials which might be developed as sources of tannin. Work on groundnuts was extended and advice given on breeding and analytical problems of the oil palm.

The tenth annual report of the Colonial Products Research Council records the completion of the clinical trials of the fungistatic antibiotic, comirin, whereby application of comirin was effective in twelve cases of otomycosis in which the isolated organisms were an *Aspergillus* species or the yeast *Candida parapsilosis*, and promising results were also obtained in the treatment of various forms of tinea. Most of the cultures added during the year to the Hankey Culture Collection (which now comprises 547 strains) were dermatophytes isolated in the work on comirin. Prof. C. H. Hassall and his collaborators have improved the methods of isolating and purifying the antibiotic monamycin, and progress is also reported in the separation and characterization of the active materials in the monamycin complex. In the Sugar Technological Laboratory at the Imperial College of Agriculture, Trinidad, pilot-plant trials have indicated that superstats had no significant effect on scale formation. Methods for the production of sugar-cane wax were improved, and the hard waxes obtained by the new process from filter-press muds should compete with carnauba in the preparation of high-grade polishes. Results obtained in the production of lactic acid and its esters from molasses were sufficiently promising to justify installation of a pilot plant, and a 10 per cent yield of itaconic acid has been obtained on the sugar by culture of an *Aspergillus*, using the techniques adopted in penicillin manufacture.

The technique for the bulk preparation of the crude *Striga* germination factor has been improved and the method of testing stimulatory solutions modified. In work on carbohydrates, Prof. M. Stacey and his collaborators at the University of Birmingham have confirmed by chemical methods that the polysaccharide produced by the enzyme derived from *Acetobacter capsulatum* is a true dextran and have determined the structure of the dextran produced by a strain of *Betacoccus arabinosaceus*; in addition, they have initiated fundamental studies on the enzymes responsible for the synthesis of the main chains of α-1 : 6-linked glucopyranose units and the branch points involving the α-1 : 3 linkages. Prof. A. C. Frazer and his colleagues at the University of Birmingham have shown that histamine release by dextrans is dependent upon concentration and size; and in Prof. S. Peat's laboratory in the University College of North Wales, Bangor, further evidence was obtained of the unbranched character of the maltosaccharides from amylose by their reduction to the corresponding alcohols with sodium borohydride; and from this reduction technique a new micro-method was developed for determining the molecular weights of maltosaccharides. Partial hydrolysis of the 'insoluble' lamarin of *L. cloustoni* yielded the three disaccharides, laminaribiose, gentiobiose and ββ-trehalose, and five trisaccharides, containing permutations of the β : β-, β : 3- and β : 6-links to be expected from the nature of the disaccharides.

The component glycerides of coconut and palm-kernel oils have been shown to consist of complex mixtures of mixed glycerides. Conophor oil, from *Tetracarpidium conophorum*, gave highly satisfactory results in technical trials, and Prof. H. D. Kay found that the cake remaining after the oil extraction was palatable to most cows and may form a good protein concentrate.

The ninth annual report of the Colonial Social Science Research Council records little change in the

recruitment position: difficulties in obtaining senior staff and for demography and legal sociology continued. No Colonial research fellowships in the social sciences were awarded during the year; but the Council has set aside £10,000 for junior fellowships attached to Colonial universities and university colleges during 1953–56, and the Goldsmiths' Company is awarding two scholarships tenable at African university colleges in 1953. The five American social anthropologists appointed under the special scheme for training American scientists at British universities have now all returned from the field, and Dr. E. W. Winter's report on the Baamba is in its final stages. The first of a series of official visits to the regional institutes of social and economic research to consider probable requirements after March 31, 1956, was made to the West Indies Institute of Social and Economic Research at the end of March 1953. Detailed reports of the work of the regional institutes are appended to the Council's report. A Social Research Unit has been set up by the University of Malaya and was to start work in 1953. The report includes a survey of research in the Colonial territories financed independently of Colonial Development and Welfare Funds and notes particularly the work of the East African Statistical Department on the best methods of estimating population growth in under-developed territories; the inquiry into the political institutions of the districts in Tanganyika; and the inquiry of the Education Department of Northern Rhodesia into relative standards of children born in North Rhodesia and elsewhere, the effect of a different mother tongue, of health, occupation of parents, etc., on education and progress of European scholars. The Education Department of the University of Malaya completed its word-frequency count of written Malay.

Seven sections of the Ethnographic Survey of Africa were published during 1952–53, and eight other sections were in the press. Part 2 of the General Survey in the "Handbook of African Languages"—"The Languages of West Africa"—was published, and Part 3, "The Languages of East Africa", was being prepared for the press. Mr. Arnold Epstein's report on his legal studies in North Rhodesia was published under the title "The Administration of Justice and the Urban African". Work is well advanced on the programme of anthropological studies in Sarawak, and the West Indian volume of the Demographic Survey of the British Colonial Empire was expected to be published. A list of publications during the year by workers assisted from Colonial Development and Welfare Funds is appended to the Council's report.

Of the twenty-one research schemes under the scientific supervision of the Colonial Medical Research Committee at the beginning of the year, that for the study of malaria in North Borneo and Sarawak has been concluded, and that for the study of leprosy in Malaya is in abeyance. The Committee's eighth annual report records the filling of five vacancies, and the facilities of the overseas research units have been much used by specialist workers from the United Kingdom for the short-term study of specific problems. In West Africa steps are being taken to transform the Standing Advisory Committee into an appropriately enlarged West African Council for Medical Research, which will have under its supervision the Virus Research Institute at Yaba (to be renamed the West African Council for Medical Research Laboratories), the Hot Climate Physiology Research Unit at Oshodi, the Leprosy Research Unit at Uzuakoli, and the Loiasis Research Unit at Kumba, and will develop further research on malaria, yaws and tuberculosis. The East African Medical Survey, now a compact and active group, with ample housing and laboratory facilities, has been concerned essentially with fact-finding in the field of public health. Continued work at Kumba in the Cameroons on the breeding of larvæ, and on the flies of the forest canopy, brought to light two new species of Chrysops, three species not previously known in West Africa, and three previously known only as the prey of wasps in the Congo. *Culicoides austeni* has been shown to be a vector of *A. perstans* in the area, and surveys of infections with *Loa loa* and *A. perstans* in the human populations in the rain forests, the forest fringe and the mountain grasslands of the British Cameroons have shown that both parasites reach an equilibrium of high incidence and intensity in small villages in the rain forest, the incidence and intensity falling very rapidly in the areas of derived savanna and forest relict, while neither infection is transmitted in the grassland. Investigation of the chemoprophylaxis and chemotherapy of filarial infections continued at the Liverpool School of Tropical Medicine.

A survey of the incidence and distribution of filariasis in the Southern Highlands of Tanganyika was made in September and October 1952, and additional investigations of filariasis are reported from the Institute for Medical Research, Malaya, where the risk of introducing the Pacific (non-periodic) variety of *Wulcheria bancrofti* through the arrival of Fijian troops has been lessened by screening contingents destined for Malaya and by treating microfilaria carriers with 'Hetrazan' before arrival: the Institute is co-operating in periodic examinations of the whole battalion. Malaria research in North Borneo, Sarawak and Brunei was terminated in 1952 after providing a method of eradication, by clearing scrub and admitting sunlight, which at the same time encourages the economic development of the land and the prosperity of the people. The work has also provided a basis for future malaria work in Borneo, and the observations suggest a method of control which may be applicable elsewhere in the East in jungle areas where *A. leucosphyrus* may be the vector. The work of the East African Malaria Unit was concerned mainly with the daytime distribution of the resting-sites of *A. gambiae* and *A. funestus* in houses and outside, and with the relation of the blood-meal to ovarian development. Studies in Trinidad on the effect of residual insecticide spraying in three mud-huts fitted with exit traps of the Muirhead-Thomson pattern indicated that an aqueous suspension of DDT was effective up to five months and 'Gammexane' only up to less than two months, although, when fresh, 'Gammexane' had a repellency effect to entrance. On the Gold Coast the human reservoir of malaria infection in villages in a hyperendemic area was investigated from headquarters in Accra. A full report on trials of chloroquine, amodiaquin and pyrimethanine in Malaya is in preparation, and further tests of residual insecticides in window-trap huts have also been made on Malayan mosquitoes.

The East African Virus Research Institute, Entebbe, Uganda, where expansion on the clinical side is desirable, has concentrated its field-work on yellow fever in the drier country, where bush-babies (*Galago* spp.) and not monkeys appear to be the main

animal hosts of the virus. Some survey work on the Rift Valley fever virus was carried out and a strain of the Coxsackie virus was isolated from a member of the Institute's staff. In the work of the Scrub-Typhus Research Unit based on the Institute for Medical Research, Malaya, the emphasis was shifting to other infections which involve animal reservoirs, and the revised objective of the Unit is a continued study of animal ecology with special reference to medical problems. The work of the United States Army Medical Research Unit (Malaya), of which a summary is again given, has included studies of the resistance to penicillin and carbomycin of staphylococci from North Borneo, Malaya and the United States; investigations on Trombiculid mites were to be resumed in 1953. Surveys were made of relapsing fever in the Usambara Mountains, Tanganyika, and in the Teita Hills and Kwale district in Kenya. At the Lister Institute of Preventive Medicine a special study was made of the sera of the African species of the family Bovidae, and a completely new technique for identifying blood-meals of closely related species was being investigated, while the studies continued of serum proteins, of nitrogen balance and water content, and of hæmatology.

The Hot Climate Physiology Research Unit at Oshodi, Nigeria, completed a survey of the energy cost of most of the everyday tasks of the farmer, and started one of purely industrial tasks, particularly the energy cost of head-carrying. At the Uzuakoli Leprosy Settlement, Nigeria, pharmaceutical and therapeutic studies of sulphones have confirmed that small oral doses of 'Dapsone' are an effective, simple, safe and widely practicable form of chemotherapy of leprosy, and the good results previously recorded with *p*-acetamidobenzaldehyde thiosemicarbazone have been confirmed. In Nigeria the findings of the previous goitre survey were confirmed; the areas of obvious goitre lie on granite or are associated with granite outcrops in marine sediments or with drainage areas off granites, and such areas have been mapped in consultation with the Nigerian Geological Survey. The Field Research Station, Fajara, Gambia, continued its investigations into nutritional disorders, including the study of methods of determining the amino-acid content of tropical foods, and the scope of the work was extended to include studies on filariasis and schistosomiasis (particularly the treatment of elephantiosis of the leg) and the mosquitoes which may transmit *W. bancrofti* in the Gambia. Some notes are included on the medical work undertaken and financed by the Medical Departments of Colonial Territories—for example, the treatment of malaria with daraprim in Kenya, clinical trials of 'Sulphetrone', 'Dapsone', 'Thiacetazone', 'Ethizone', 'Isoniazid' and 2-anilino-3-amino-5-phenylphenazide hydrochloride at the Leprosy Hospital, Makogai, Fiji, and a study of 'vomiting sickness' in Jamaica.

Grants totalling £372,286 were made during the year for new and existing schemes from Colonial Development and Welfare Funds by the Committee for Colonial Agricultural, Animal Health and Forestry Research, the annual report of which again acknowledges particularly the assistance of the Commonwealth Institutes of Entomology and of Biological Control and of the Commonwealth Mycological Institute. Progress in some sections of the East African Agriculture and Forestry Research Organization was retarded by the declaration of a State of Emergency in Kenya, but research in soil microbiology was started and a satisfactory technique for inoculation of maize for resistance to the American rust disease caused by *Puccinia polysora* Underw. was taking shape as a result of co-operative work with Amani as well as the Kenya and Uganda Departments. Co-operative work with the Cotton Research Station, Namulonge, has demonstrated the repellent effect of certain insecticides against the *Lygus* pest. Soil surveys at different category-levels were continued as well as laboratory work on the fertility of tropical soils. The major buildings and other facilities of the new headquarters of the East African Veterinary Research Organization at Muguga South were completed or well advanced by the end of the year under review, and earlier findings have been confirmed that treatment of bovine trypanosomiasis with 'Antrycide', while effective in the early stages, is much less so in advanced trypanosomiasis, and that prophylactic treatment of cattle in contact with tsetse fly should be given at least once every two months. The main factor determining the success of the drug in protecting cattle appears to be the severity of the challenge by trypanosomes, which in turn depends on the nature and number of the tsetse flies to which the cattle are exposed. Research was continued on the systematics and life-cycles of the paramphistones of domestic ruminants.

At the West African Cacao Research Institute demonstration of the control of swollen shoot by regular inspection and cutting-out of symptom-bearing trees and replanting was continued, as well as investigations on the symptoms and classification of cacao virus strains from the Gold Coast, Nigeria and the Ivory Coast, and on the mealybug vectors of these strains; and the search went on at the West African Rice Research Station, Rokupr, Sierra Leone, for maize varieties which combine high yield and resistance to attack from the rust disease pathogen *Puccinia polysora*. At the British West Indies Central Sugar-Cane Breeding Station, Barbados, further progress was made in the pure-line breeding programme, and a satisfactory cytological technique, involving pre-treatment of root-tips in α-bromonaphthalene solution to condense and spread metaphase chromosomes, was evolved. Investigations at the Imperial College of Tropical Agriculture, Trinidad, strengthen the opinion that the deterioration of cacao soils is due to loss of litter, crumb, and highly organic top-soil through erosion, wastage by oxidation of organic matter and nutrient exhaustion. The ecological land-use survey of British Honduras commenced in August, and the preliminary ground survey of the Northern, Corozal District was virtually complete by the end of the year under review. Among researches undertaken by the Colonial departments may be mentioned one in Barbados on the control of cane-root-destroying pests, such as *Diaprepes abbreviarus*, *Clemora ornithi*, and *Acropyga* ants and wood ants in cane fields with the gamma isomer of benzene hexachloride diluted with milled coral limestone; in the Gold Coast on the control of maize-stem borers with DDT and benzene hexachloride preparations; on the improvement of biological control of coffee-mealybug (*Planococcus kenyae*) in Kenya by introducing and establishing further species of natural enemies from Uganda; studies on the control of black pod disease of cocoa (caused by *Phytophthora palmivora*) in Nigeria; the studies of control of tick-infestation of cattle in Northern Rhodesia, which indicate the wide field of application in Africa for the portable power-spray; and of the *Theraptus*

damage to coconuts in Zanzibar, where an experimental double aerial spraying with DDT in oil formulation was given to five hundred acres of coconut plantation.

The sixth annual report of the Colonial Insecticides, Fungicides and Herbicides Committee includes an account of the work of the Colonial Insecticide Research Unit at Porton, where studies continued on the sorption of insecticides by certain types of dried mud used for native houses in many parts of the tropics in an attempt to explain the relatively poor effect of DDT against certain species of mosquito (notably *Anopheles gambiae*), and a preliminary wind tunnel study was made of the deposition of small particles on various obstacles, including tsetse flies, at low wind speeds. Air-borne drops appeared to be deposited more readily on tsetse flies at rest on the obstacles than on the obstacles themselves, and for such deposition the optimum drop-size range with the cylinders and disks used at wind speeds of up to 4 m.p.h. is 10–30 μ, although since drops in this size-range are not collected efficiently by the cylinders and disks, larger drops are required for deposition on them. A team from the Unit continued the aircraft-spraying trials against tsetse flies in field experiments at Urambo in the western Tanganyika *morsitans* belt and at Maruzi in Uganda in thicket typical of much tsetse brush in East Africa, and very promising results were obtained by aircraft spraying five hundred acres of coconuts infested with a coreid bug (*Theraptus* sp.) at Zanzibar using a 9·2 per cent solution of DDT in oil as well as in spraying with a DDT emulsion five hundred acres of beans near Arusha, which were heavily infested with larvæ of the American bollworm (*Heliothis armigera*).

The malaria eradication experiment in Mauritius was terminated: malaria transmission virtually ceased with the elimination of *A. funestus*, and the reduction in houses of *A. gambiae*. A full report was in preparation of the experiment in malaria control in Malaya, now terminated, in which promising results were obtained with both DDT and benzene hexachloride. Very promising results were obtained in defoliation experiments with bush infested with *G. palpalis* and *G. pallidipes* in Kavirondo, Kenya; but in the experiments with the *n*-butyl esters of 4-chloro-2-methylphenoxyacetic acid, 2 : 4-dichlorophenoxyacetic acid and 2 : 4 : 5-trichlorophenoxyacetic acid, overall spraying of regenerating savanna-thorn bush at Shinyanga, East Africa, and regenerating *Isoberlinia* woodland at Kikaro when the regenerating shoots were 2–4 years old over a two-year period failed to eradicate the bulk of the species.

At the Imperial College Field Station, Silwood Park, transport of DDT solutions in lanoline across the integument of blowflies was investigated and studies of the contamination of flies exposed to particulate deposits continued. At Rothamsted Experimental Station the rate of loss of insecticidal effect of DDT deposits on living foliage in the glass-house was studied under various conditions. In Uganda investigations on the control of blackarm disease of cotton were completed, while in Malaya control of insect pests troublesome in the field establishment of young cacao were controlled by soil treatment with benzene hexachloride and dusting the plant with DDT wettable powder.

The Colonial Economic Research Committee still finds it difficult to recruit qualified candidates, but the decision to invite universities and university colleges to propose schemes for economic research has had good results. The Committee's sixth annual report records that Dr. J. Greaves's monograph on "Colonial Monetary Systems" was in the press, as was Dr. A. R. Prest and Mr. I. G. Stewart's report on "Nigerian National Income, 1950–51". The Committee has approved three grants: for Dr. F. C. Wright's study of the structure and organization of the distribution in Tanganyika and Nyasaland; towards half the recurrent expenditure of an Economic Research Unit at the University College of the Gold Coast until March 31, 1956; and for a scheme to promote the study at the University College of the West Indies of the methodology of capital formation, with special reference to capital investment in Jamaica.

The report of the Tsetse Fly and Trypanosomiasis Committee for 1952–53 records further advances in the integration of tsetse research and of research on human and animal trypanosomiasis in East Africa. Satisfactory results have been obtained in experimental reclamation projects, and pilot schemes of practical reclamation in conjunction with the utilization of land have been started in the three mainland territories. The Antrycide Research Scheme was terminated at the end of March 1952, but investigations were being continued under the Trypanosomiasis Research Laboratory. The West African Institute for Trypanosomiasis Research also reports satisfactory progress. Reports on the use of 'Antrycide' methyl sulphate for curative purposes continued to be generally favourable. Special attention was given to the study of *T. vivax*, including work on its transmission by *G. palpalis*.

The annual report on Fisheries Research of the Colonial Fisheries Advisory Committee records that the number of fishery officers was stabilized at about fifty-four, and recruitment and training were largely concerned with replacements. Commitments for new schemes and for the extension of existing ones until March 31, 1956, are estimated at £85,510, with an uncommitted balance of £68,800. At the Inter-territorial Fisheries Research Station at Jinja a new technique to determine chemical deficiencies in lake waters has been developed, using algal cultures as indicators, and results have shown that sulphates may sometimes be the primary deficiency. Considerable advances have been made in studies on the taxonomy of the fishes *Haplochromis* and *Tilapia*. At the Inter-territorial Marine Fisheries Research Station at Zanzibar the emphasis has been on the distribution of the big surface fishes, while continued experiments at the West African Fisheries Research Institute on the control of marine wood-borers by concussion have shown that, while detonation by small explosive charges greatly decreases the incidence of the common shipworm *Teredo*, it is ineffective against the Martesia wood-borer. No progress is reported at the Research Station for Fish Culture in Malaya.

The report on Locust Research and Control, 1952–53, covers the work of the Anti-Locust Research Centre, which received 1,265 reports on the locust situation from forty-one countries and territories. Besides its studies of factors affecting the rate of sexual maturation in the desert locust, it carried out with the Desert Locust Survey investigations, on the Somali peninsula, on swarms of desert locusts during August–November 1952, which threw some light on the mechanism of displacements associated with the Inter-Tropical Convergence Zone. During the year

the desert locust situation, in contrast to that in the outbreak areas of the African migratory and the red locust, was extremely serious, particularly on the Somali peninsula and in Arabia. In the Somali Peninsula and the coastal areas of Saudi Arabia it was brought under control by the Desert Locust Control Organization of the East Africa High Commission, in co-operation with the Saudi Arabian and Ethiopian authorities and the Somali Administration.

LIMITS TO A FIRM'S CONTROL OF LABOUR TURNOVER

By Dr. HILDE BEHREND

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LIKE all social and economic phenomena, labour turnover is determined by the interaction of numerous factors involving both economic and non-economic motives. While all these factors operate simultaneously, some of them exert a much stronger influence on the level of turnover than others. The ability of a firm to limit its labour wastage will depend on the strength of the influence on turnover of factors which it can control or modify; it cannot hope to alter a high turnover-rate if it is due to external factors, outside its control.

Opinions differ about the weight which must be attached to external and internal factors as determinants of labour turnover. Some writers, such as Florence[1], Long[2] and James[3], emphasize the importance of external factors while acknowledging that the firm has a part to play. Other writers, for example, Cook[4] and Greystoke[5], stress the significance of the individual firm. The Tavistock Institute team, Rice, Hill and Trist[6], take up an extreme position and assert that labour turnover is a "function of an industrial organisation as a social institution", and this view, which is not backed by valid evidence, appears to have gained considerable ground in recent years. (For an examination of the validity of evidence, compare Behrend[7].) My own research points to a different hypothesis.

The problem is one of finding objective criteria to assess the relative influence of external and internal factors on labour turnover. In developing a technique the following considerations are of importance. While labour turnover must be regarded as a function of both external and internal factors, it is conceivable that the *difference* between two labour turnover-rates can be traced back to only one group of these variables. As external factors operate in the whole community, their influence, if it exists, must be noticeable in many firms and not restricted to one firm. Therefore, if we discover evidence that there exist certain types of differences in turnover which are found in the majority of factories, external factors can be assumed to be at work. On the other hand, the effect of internal factors must be restricted to one particular plant. Thus, if we find an isolated instance of an observed significant difference in turnover, internal factors can be assumed to be at work.

The extent of the incidence of differential turnover-rates or of changes in labour turnover thus provides a criterion for assessing the influence of external as opposed to internal factors on labour turnover.

This criterion can be applied to the findings of labour turnover research which has revealed that the following five types of differences in labour turnover at the same point of time exist among workers in manufacturing plants (cf. refs. 1–5 and others).

(1) Labour turnover differs for the sexes. In practically all factories in England it is higher for women than for men in the same age and length of service group. It must be stressed, however, that this is linked with type of work (cf. ref. 4).

(2) Labour turnover varies for different age-groups. It tends to decrease with age, at least after the age of thirty, and this fall appears to be fairly universal.

(3) Labour turnover differs for workers with different lengths of service. It is well known that in all factories turnover is highest among newcomers and lowest among long-service workers.

(4) Labour turnover differs with type of work. It tends, for example, to be lower for skilled workers than for unskilled ones. Contrary to expectation, there appears to be no evidence that these variations are linked to differentials in wage-rates or earnings.

(5) Labour turnover varies with the number of jobs in the local labour market. In a large town with many factories wastage-rates tend to be higher than in an isolated area where one factory is the main employer.

Labour turnover thus differs with sex, age, length of service, occupation and employment opportunities. These five types of variations have been found to be general phenomena, observable in the majority of factories, and must thus be attributed to the operation of general external factors.

It follows from these findings that comparisons of the level of turnover of different factories and departments at the same point of time, with the view of isolating the effect of the firm on labour turnover, should be based on standardized rates, namely, on age-specific turnover-rates for men and for women in given occupations belonging to specific length-of-service categories and living in similar labour markets. So far as I know, the construction of such rates for inter-factory comparisons has never been attempted.

Fortunately, standardization of turnover-rates is mainly essential when comparing different factories or departments at the same point of time; it does not appear so necessary when one is comparing figures for the same factories or departments for successive periods of time provided they have fairly stable population structures. (The comparison would be based on the simplifying assumption that the characteristics of the population do not change significantly from one year of observation to the next and must be restricted to factories with stable population numbers.)

When studying successive periods of time, external factors can be deemed to be at work if certain changes in labour turnover occur in the majority of factories, while internal factors can be assumed to be operating if the observed change is an isolated event restricted to one firm, factory or department, not experienced by a control group of factories, or deviating from the trend of the control group.

A considerable amount of evidence is available to show that changes in external factors lead to widespread and marked changes in the level of labour turnover. Data published by Florence[1], Long[2], Woytinsky[8] and myself[9] show that changes in the level of turnover correspond to changes in the level

of employment. Under full employment labour turnover tends to be high, and it falls with rising unemployment. As small an increase in the unemployment-rate as a rise of 0·4 percentage points was found to have led to a very marked reduction in the level of labour turnover[9].

The course of the Second World War can also be shown to have affected the level of labour turnover[2].

What is the effect of changes in internal factors? Firms claim that introduction of the incentives and bonus schemes, of personnel management, of induction and training schemes, and of better management and supervision will each lead to a fall in labour turnover. Yet it is extremely difficult to find valid evidence to prove this. Most of the claims of success are not substantiated by data for control groups. In published literature and in data collected by myself, I have been unable to discover more than four cases of the effective reduction of labour turnover in experimental plants, where the control groups showed no corresponding change.

Florence[1] quotes a study made by the U.S. Department of Labour in 1920 which shows that the introduction of "definite labour policies and centralised employment machinery" in a number of 'experimental' establishments was followed by a reduction in the wastage-rate from well above that of the control group to less than half that of the control group. Long[2] gives an example where a change in the management and organization of a factory together with the introduction of time and motion study led to a proportionately greater fall in the male labour turnover-rate of the experimental plant than the ordinary post-war reduction shown by two other factories owned by the same firm. In a department of Company *J*, I found that a change in supervision together with a complete re-organization of the department, including the introduction of time and motion study, was followed by a remarkable drop in labour turnover, while the other departments of Company *J* showed no corresponding change. In Company *P*, labour turnover was reduced significantly from one year to the next, while other factories in the same area showed no comparable reduction. This was attributed to the combined effect of "important changes in management attitude, in pay, in conditions, in benefit plans, in the efficiency of supervision, and in other aspects".

It can be seen that these four cases all entailed a series of simultaneous and extensive changes in organization. But if really radical changes in organization take place, they probably involve changes in factors which were shown earlier to be external factors, for example, in type of work. This would be true of three of the four cases. Furthermore, such changes would normally be followed by changes in the work-force, for better work methods mean more output, and population numbers are adjusted to the output target. Other external factors such as the composition of the work force and employment opportunities are thus likely to alter.

On the whole it appears to me that all the available evidence suggests that quite small changes in external factors, namely, in the level of employment, produce far more pronounced changes in the level of labour turnover than small changes in internal factors. Only extremely radical changes in internal factors can achieve similar results; but if such extensive changes take place, they probably involve changes in external factors.

One can go one step further and say that external factors, particularly the level of employment, are the decisive factors in this field which determine not only the behaviour of individuals but also the action of firms. When the level of employment changes, the labour problems of a firm alter and this affects management's policy with regard to all aspects of labour management. Changes in external factors thus give rise to changes in internal factors. Internal factors are not independent variables, but are largely an adjustment to general factors as they affect the firm or an attempt to modify them. Under full employment, for example, the firm's response to the shortage of labour is to 'woo' workers to stay with it by the introduction of elaborate employee services of all kinds. Theoretically it would appear highly plausible that these measures are effective and reduce the high level of labour turnover. In practice, however, there is very little evidence to support the claim that labour turnover can be modified by organizational action—short of changes in the whole set-up. This appears to be so even though we know when and where action is necessary. It is needed in times of full employment, and it must concentrate on modifying the influence of age, length of service and type of work, by trying to create a sense of loyalty and 'belonging' in the newcomer and in the young worker, and by studying the type of work to see whether irritating elements of the job can be eliminated and 'traction' increased. (Traction is 'the feeling of being pulled or drawn along by the inertia inherent in a particular activity'; compare Baldamus[10].)

It may be objected that I have ignored the most important incentive the firm can offer, namely, wage-differentials, and that the payment of relatively higher wages than neighbouring plants is likely to be an effective tool of control at the disposal of the firm.

Labour turnover research, however, has provided no evidence so far to show that relatively higher wages stabilize a firm's work-force. This may be partly because the effect is difficult to isolate and partly because few firms pay high enough wage-differentials. A firm's ability to pay higher wages than its neighbours is limited by external factors, such as economic market forces which determine the receipts for its sales. Managers frequently express the belief that they cannot afford to pay higher wages because increased labour costs reduce profitability and they feel this more than offsets any gain in labour stability. They thus do not seem to consider the use of higher wages as a tool of labour control to be a workable proposition. (The introduction of wage-differentials which aim at paying relatively higher wages than other factories means that a firm pays a higher wage for a given output than previously. This must not be confused with the use of incentive payment schemes where increased pay is linked to increased output and therefore does not increase costs.)

It appears that the firm's control over labour turnover is very limited, and that labour turnover is mainly determined by factors outside the firm's control, modifiable only to a small degree. The problem so frequently discussed in economics of the different effectiveness of the 'stick' and the 'carrot' applies. Unemployment as the stick appears effective as a limiting factor to labour turnover, but we do not yet know how to make organizational policy act as an effective carrot, although firms have been

searching for such an incentive ever since the pressure from unemployment has been relaxed.

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TOTAL SOLAR ECLIPSE OF JUNE 30, 1954

A TOTAL eclipse of the sun will occur on June 30, 1954, the belt of totality stretching from near Minneapolis, where eclipse comes at sunrise, through north-eastern Canada and Greenland, across the Faroes, Norway, Sweden, the Baltic and south Russia, finally ending at sunset not far from Peshawar. Many European astronomers are proposing to go to southern Sweden to make observations, since this is an easily accessible portion of the eclipse track and the chances of a clear sky are reasonably good (about 50 per cent). Mid-eclipse comes near noon in the Faroes and in the early afternoon in Scandinavia. The belt of totality is about ninety miles wide, and near the centre line the duration of totality is 2½ minutes. The corona may be expected to be of the type associated with minimum sunspot activity. Preparations are known to be under way for parties of observers from Great Britain, Eire, France, Switzerland, Holland, West and East Germany, Italy and Canada. Swedish astronomers, who are naturally taking a very active interest, are organizing groups of observers to work at three or more separate places.

The Royal Greenwich Observatory is to send a small group to measure the gravitational deflexion of light by the sun. This is a fairly favourable eclipse for this purpose, as the star field is a good one, although the duration of totality is not specially long. Another group from Greenwich will be engaged in measuring accurate positions of the cusps for geodetic purposes. The Cambridge Observatories are planning several types of observation: (1) measurement of chromospheric line profiles with a large spectrograph giving a dispersion of about 1 A./mm.; (2) measurement of the electron temperature of the chromosphere by Zanstra's method; (3) observation of the corona in the light of the green line 5303 A., using an interference filter and a Fabry–Perot interferometer of low resolving power, to examine the distribution of line width, and of line of sight motion. This last experiment is being carried out in co-operation with the St. Andrews Observatory. St. Andrews is also sharing a project with the Potsdam Observatory, to measure the deflexion of light by the sun with an elaborate apparatus developed from that used by Potsdam observers some twenty-five years ago in Sumatra. The University of London Observatory is to carry out photographic photometry of the corona, with a new arrangement which should reduce trouble from scattered light and also should extend the range of surface brightness measurable. The Dunsink Observatory is to measure line-widths in the spectrum of the low chromosphere, using a Fabry–Perot interferometer.

All the foregoing parties will observe in various places in south Sweden. In addition, the Cambridge Observatories, with the help of the R.A.F., are photographing the outer corona in polarized light from an aircraft at about 30,000 ft. altitude, using a multi-lens camera designed for freedom from scattered light. Observers from the University of Edinburgh are also utilizing aircraft, in an attempt to detect a daylight aurora during totality. Both these flights will probably take place north of the Shetlands.

The plans of astronomers from other countries are not yet generally known; but a few details can be given here. French observers (MM. Dollfus and Michard) will use a spectrograph devised by the late Dr. B. Lyot, permitting photography of the coronal spectrum simultaneously around almost the whole sun. Dutch astronomers (Prof. M. G. J. Minnaert and Dr. J. Houtgast) will examine the Fraunhofer spectrum of the corona, and the distribution with respect to height of material in the chromosphere. Two Canadian parties intend to observe the chromospheric spectrum, one from the Dominion Astrophysical Observatory, Victoria, B.C., with a slitless instrument, the other from the Dominion Observatory, Ottawa, with a high-dispersion slit spectrograph.

OBITUARY

Dr. Karl B. McEachron

DR. KARL B. MCEACHRON, consultant to the General Electric Company at Pittsfield, New York, died in hospital on January 24, aged sixty-four years.

Dr. McEachron's name will always be associated with high-voltage research work and with the study of lightning. He was an instructor for some years in the Ohio Northern University and at Purdue, and in 1922 took charge of the research and development section of the Lightning Arrester Engineering Department of the Pittsfield factory of the General Electric Company. Here he developed techniques for producing and recording electrical transients of very short duration, and was one of the first engineers to apply surges from an impulse generator directly to overhead transmission lines in order to study the attenuation of high travelling-wave voltages and their effect on terminal apparatus. He was largely responsible for the successful production of the 'Thyrite' lightning arrester, embodying material composed of carborundum and graphite having a fourth-power voltage/current characteristic. His published work on this development is to be found in the *Transactions of the American Institute of Electrical Engineers* in the years 1928–33, and for this he received the Charles A. Coffin Award of the Edison Electric Institute in 1931 and the Lohgstreth Medal of the Franklin Institute in 1936.

In 1933 Dr. McEachron was appointed engineer-in-charge of the High Voltage Engineering Laboratory at Pittsfield and there began the study of lightning flashes striking transmission lines and—later—striking to the top of the Empire State Building, New York. He installed oscillographs on the top floor connected to the radio antennæ system of the National Broadcasting Company twelve hundred and fifty feet above street-level and placed a variety of types of Boys's cameras on the fifty-sixth floor of

500 Fifth Avenue, from which a good view of the top of the Empire State Building was obtained. Schonland had by this time established the existence of the downward directed 'leader' stroke to the lightning flash, but McEachron's paper to the Franklin Institute in 1939 showed that in fact nearly all lightning flashes to the Empire State Building begin by discharges extending in step-by-step formation from the top of the building to cloud. The oscillograms of the same lightning strokes disclosed that although the luminosity often falls to zero between the successive strokes of a lightning flash, the current through the oscillograph did not. There were long 'continuing strokes' lasting many milliseconds between the high luminosity large current strokes. McEachron showed that these continuing currents in fact carried larger charges to ground than the charge associated with the bright main strokes, and it was suggested that these 'continuing strokes' might be responsible for many strange failures of lightning arresters and may explain the cause of fires initiated by lightning. For his outstanding work in gaining quantitative data on lightning discharges McEachron was awarded the Edison Medal of the American Institute of Electrical Engineers, being the thirty-ninth holder of that Medal.

He was one of the most sought-after speakers in the General Electric Company and lectured extensively in the United States and Canada. He accumulated an immense collection of photographs of lightning, and gave visitors from overseas a most cordial welcome and a fascinating review of lightning studies. He leaves a widow, three sons and two daughters.

T. E. Allibone

NEWS and VIEWS

The Ancestry of Sir Isaac Newton

At an ordinary meeting of the Scottish Genealogy Society, held in Edinburgh on February 16, the honorary secretary of the Society, Rolland J. B. Munro, read a paper entitled "Notes on the Ancestry of Sir Isaac Newton", in which he claimed that there is a strong possibility of Newton being of Scottish descent. Newton occupied himself very much with genealogy, there being evidence of his interest in this in 1659, at the age of seventeen; and after 1705 he made a painstaking search to uncover his ancestry, leading to a great mass of papers sold at the Rodd Sale in three portions, the smallest portion of which was bound in seventeen volumes. Mr. Munro's main argument was that it was Newton himself who, as a result of these investigations, claimed Scottish ancestry. Sir Isaac's grandfather, Robert Newton, undoubtedly bought the manor of Woolsthorpe, and Mr. Munro maintains that Robert had left Scotland with the court of King James VI of Scotland, afterwards to become James I of England. Sir Adam Newton, Bart., of Charlton in Kent, the son of an Edinburgh baxter and burgess, a scholar of high repute and favourite of Andrew Melville, was tutor and secretary to Henry, Prince of Wales, the elder son of James, who died early. Sir Adam also had a brother Robert, and it is suggested that he became Robert Newton of Woolsthorpe and lord of that manor; for, if he were an Englishman, his ancestry seems to be enigmatic. The Charlton Newtons are clearly a cadet of the Newtons of that ilk in East Lothian, from whom, so Sir Isaac is said to have stated, his grandfather claimed kinship and descent. Evidence was shown by Mr. Munro that the Lairds of Long Newton in East Lothian had suffered by adherence to the cause of Mary Queen of Scots, that one of them went to England, and that for these financial and material hardships they were rewarded by James VI. Robert and James Newton followed with Sir Adam, but were not so lucky as the latter, and each, it may be significant, eventually went to the University of Padua, where Galileo had taught the doctrines to which Sir Isaac added his intellectual seal. Attention was also directed by Mr. Munro to the fact that one of Newton's relatives owned Gordon Mill, near Kelso, during Sir Isaac's life-time, and that this cousin lived with him for a period.

Continued Employment of Older People

Replying in an adjournment debate on the employment of older men and women in the House of Commons on February 5, the Parliamentary Secretary to the Ministry of Labour and National Service, Mr. H. Watkinson, pointed out that the National Advisory Committee on the Employment of Older Men and Women is a standing committee which has only just started its work. The research sub-committee also set up meets frequently, and other sub-committees will be established if necessary. Mr. Watkinson urged that the whole problem should be examined in the light of two principles: capacity, not age, should be the first consideration in recruiting staff or engaging people, and all who can continue to give effective service in their occupation should have the opportunity of continuing, if they wish, irrespective of age. Mr. Watkinson referred particularly to the shortage of skilled engineering craftsmen and to the value of older craftsmen as a reservoir of skill, who could at least be employed for shorter hours or as instructors. With regard to the professional man and the obstacle which pension schemes present to continued employment, he said that the Association of Superannuation and of Pension Funds had authorized him to state that the Association could show any employer who felt that a pension fund or superannuation fund is a bar to the employment of older men and women how to modify that policy. After referring to the efforts of the Ministry to influence opinion and to spread the knowledge of what the Advisory Committee is doing, Mr. Watkinson appealed for the co-operation of employers, trade unionists, members of Parliament and all people of goodwill in solving a problem which is of vital importance to the national economy and to the health and happiness of older people themselves.

Nationalized Industries and Accountability

In opening a debate in the House of Commons on February 8, on the Report of the Select Committee on the Nationalized Industries, the Lord Privy Seal, Mr. H. Crookshank, said that in principle the Government accepts the idea of a select committee and also the recommendations of the present report on that subject, subject to modifications and to consideration of the views expressed in Parliament. The Government would prefer to keep open the

possibility of a joint select committee of both Houses. While the Government agrees entirely that the terms of reference of the proposed committee should not enter into questions of detailed administration, it does not agree with the proposal that the committee should inquire into future plans and programmes as suggested in the report. To commence with, the Government thinks that the committee should not exceed ten to fourteen members, and that it would be a mistake to provide the committee with a permanent officer of the House, such as the Comptroller and Auditor General. It prefers the alternative suggestion of beginning with a clerk from the committee office and with someone of the nature of a Treasury liaison officer. If an independent officer is then found to be required, the matter could be considered by Parliament. Tentatively, Mr. Crookshank suggested that it would be much wiser not to publish all the evidence but merely reports from time to time, and it is not thought that every industry should come, in some form or other, before the select committee each year. It should be made clear that the constitution of the committee should not touch in any way the existing rights of ministers under legislation.

Auditing of Non-Recurrent Grants to British Universities

In a Special Report from the Committee of Public Accounts (Session 1953–54: Treasury Minute and Abstract of Appropriation Accounts, 67. London: H.M.S.O., 1954; 1*s*. net) the Treasury refers to the recommendation of the Committee, in its third report for session 1952–53, that the books and accounts of the universities of Great Britain relating to their expenditure of non-recurrent grants should be open to inspection by the Comptroller and Auditor General. The Treasury reiterates that it has no reason for thinking that the sums voted have not been wisely administered. The essence of the relations between the universities and the Government has been that the Treasury should avoid any detailed control of the activities of universities. Neither the Treasury nor the University Grants Committee has ever claimed the right to examine the universities' books, and the Treasury believes that to do so in the way suggested by the Committee would lead to increased intervention and extended control in a way which would prejudice the present harmonious relation between the universities and the University Grants Committee. The Treasury, however, foresees no difficulty in making satisfactory arrangements with the universities which would enable the Public Accounts Committee to satisfy itself that the grants are duly appropriated to meet the expenditure for which they are made, though the precise part to be played by the universities' auditors and professional advisers will require consideration. With regard to the more important question of ensuring economy in the expenditure of non-recurrent grants, the Treasury is considering whether the assurances desired could be obtained by some other means; thus the University Grants Committee might appoint one or more persons to report to it on any changes necessary to ensure that the methods adopted by the universities for contracting and recording and controlling expenditure are reasonably designed, and properly applied, to provide effective safeguards against waste, extravagance or other abuse. Such a report would be made available to the Public Accounts Committee with a note of any action taken or proposed. The Treasury proposes to discuss this matter with the university authorities.

Co-ordination of Research in Scotland

In reply to a question to the Secretary of State for Scotland, on February 2, referring to co-ordination between government, industrial and university laboratories for pooling the results of their scientific and technological research work, Mr. J. Stuart stated there is free exchange of research information between the universities, industrial research associations and the Department of Scientific and Industrial Research. That Department operates a technical information service available to large and small firms alike, and the research associations provide industrial liaison services to their member firms. The Department is arranging with the Scottish Office for a study of the special needs of small firms in Scotland for research and technical information.

Absenteeism of Workers in Small and Large Organizations

Under the title "Size and Morale: Preliminary Study of Attendance at Work in Large and Small Units" (pp. 44; London: Acton Society Trust, 1953; 3*s*. 6*d*.), the Acton Society Trust has issued a report covering three inquiries: one in the coal industry, one in a large industrial group and one in a large retail organization controlling 230 stores throughout Great Britain. All three inquiries showed that, as a general rule, workers are absent from work for one reason or another more frequently in large concerns than in small ones. The trend is particularly noticeable in the coal industry; it is fairly marked in the industrial sample, and just discernible in the commercial undertakings that were studied. The investigation showed that miners in the smaller pits appeared to take much more interest in the affairs of their own pit than did men working in larger pits. Further, absenteeism and accident-rates were statistically correlated with size throughout the coal industry, and, when similar geological conditions were being worked, output per man-shift tended to be higher in small pits than in large. It is not suggested that workers' morale is necessarily worse in large than in small units: the study emphasizes that there is an urgent need for detailed descriptive studies of individual working organizations if the significance of size is to be understood fully, and that investigations into the social and human factors are likely to provide the most valuable clues. Studies of the social effect on absenteeism of the distance of travel of the worker to his place of employment and of the effect of the number of hierarchical stages in the line of communication between the employee and the local manager are suggested as promising lines of inquiry.

Trends in Trade Union Organization

In 1894, the year when the Webbs published their first edition of the "History of Trade Unionism", the Labour Department of the Board of Trade recorded 1,314 trade unions with a total membership of 1,530,000. By the end of 1951 the number of unions had fallen to 704 and the total membership had reached 9,480,000. In 1894 the average number of members per union was 1,160, whereas in 1951 it was 13,452, a twelvefold increase. These broad statistical changes clearly indicate that trade unions have grown larger; but what they do not reveal is the degree to which union membership is concen-

trated in relatively few of them. In 1951 seventeen unions with a membership in excess of 100,000 accounted for 6,305,000 members. Although trade union membership is to-day highly concentrated, it is spread through a far greater range of occupations and industries than it was sixty years ago, when it was drawn in the main from a few that had become reasonably well organized during the nineteenth century. These changes in trade union structure and organization are described by P. C. Roberts in an article based upon considerable investigation and much practical experience in a recent issue of the Unilever magazine, *Progress* (**43**, No. 240, autumn 1953).

Investigations in Physics published in Russian and other Slavonic Languages

Among the resolutions passed during the General Assembly of the International Union of Pure and Applied Physics held in Copenhagen during 1952 was a recommendation that action should be taken to publish papers reviewing the work done in various fields of experimental and theoretical physics and published only in Russian and other Slavonic languages. As a result, the organization of this task was undertaken by the permanent secretariat of the Abstracting Board of the International Council of Scientific Unions, and a number of reviews of work done in the U.S.S.R. and countries of Eastern Europe have been prepared, each containing a bibliography on the subject in question. A supplementary number of the Italian journal of physics *Il Nuovo Cimento* is being prepared (Supp. to Vol. 10, Series 9) and will be available shortly, containing the following reviews: Soviet physics (J. Turkevich); mechanical twinning (R. W. Cahn); recent Soviet work in the field of crystallography (A. L. Mackay); crystallography in Eastern Europe (A. L. Mackay); théorie de la liaison chimique (M. Magat); sur les travaux de magnetisme en U.R.R.S. (S. Rosenblum); recent research on superconductivity in the U.S.S.R. (D. Shoenberg); Polish physics (W. J. Swiatecki); recent research on cosmic radiation in the Soviet Union (G. Wataghin); and recent Russian work on liquid helium (J. Wilks). The number of copies will be necessarily limited, and those wishing to order a copy who are not regular subscribers to *Il Nuovo Cimento* should write at once to either Nicola Zanichelli, Editore, Via Irnerio N.46, Bologna, or to Prof. G. Polvani, Direttore, Via Saldini N.50, Milano. The price of the Supplement will be about 2500 lire.

Classification of Vegetation

In a search for objective methods to be used in the classification of vegetation, D. W. Goodall (*Austral. J. Bot.*, **1**, 3, 435; 1953) has directed attention to the concept of fidelity as originally advanced by a Swiss school of plant ecology. This idea is bound up with the concepts of characteristic species; that is, plant communities were classified according to the presence or absence in them of small groups of 'characteristic' species much more common in one particular community than in any other. In the present investigation Goodall has attempted to express the concept of fidelity quantitatively. A new index of fidelity is described, based on the ratio of frequencies for the species in two communities. The importance of significance tests in determining characteristic species is emphasized. The value of a species as indicator of a particular community is taken as the ratio of the frequency in that community to the frequency elsewhere within the area studied. An index to express this is proposed. The value of discriminant functions in enabling vegetation samples of uncertain affinities to be allotted to one of several possible communities is demonstrated. An example is given in which this technique has been used to determine whether one community can be regarded as intermediate between two others, or has special features of its own.

Radio Industry Council Premiums for Technical Writing

The Radio Industry Council has awarded premiums of 25 guineas each for articles on radio published in the public technical press during 1953 as follows: G. G. Gouriet (spectrum equalization; *Wireless Eng.*, May); A. W. Keen (triode transformation groups; *Wireless Eng.*, October); A. H. Beck and A. D. Brisbane (a cylindrical magnetron ionization gauge; *Vacuum*, April 1952 and published April 1953); Dr. D. McMullan (the scanning electron microscope and the electron-optical examination of surfaces; *Electron. Eng.*, February); H. M. Davis and Miss J. E. Seaborn (a linear sweep cathode-ray polarograph; *Electron. Eng.*, August); J. R. Pollard (selective calling for radio-telephone systems; *Electron. Eng.*, December). The Radio Industry Council's Premiums for technical writing were first awarded last year by the Council for articles published in non-private periodicals during 1952, the object being to encourage the writing and publication of articles reporting technical progress and development of radio, television and electronics in Great Britain. Any writer is eligible who is not paid a salary wholly for writing and is earning less than 25 per cent of his income from fees from articles or from book royalties.

British Glaciological Society: Officers for 1954

The following have been elected officers of the British Glaciological Society for 1954: *President*, G. Seligman; *Vice-Presidents*, Rt. Rev. W. L. S. Fleming, Bishop of Portsmouth, W. V. Lewis, K. Sandford and J. M. Wordie; *Chairman of the Committee*, V. E. Fuchs; *Secretary*, Mrs. H. Richardson (c/o Scott Polar Research Institute, Lensfield Road, Cambridge); *Honorary Treasurer*, T. H. Best; *Honorary Editor of the Journal of Glaciology*, G. Seligman (Little Dane, Biddenden, Ashford, Kent).

South African National Committee on Geochronology

The first meeting has recently been held of the South African Committee on Geochronology, a new body which is under the sponsorship of the South African Council for Scientific and Industrial Research. The Committee has been formed "to take note of developments in this field in South Africa and overseas, and to do all it can to further them". Its members are at present: Dr. B. F. J. Schonland (*Chairman*), Dr. L. T. Nel, Dr. S. H. Houghton, Dr. E. J. Marais, Dr. D. Schreiner, Mr. R. T. Jamieson and Mr. J. D. Louw (*Honorary Secretary*).

Oil and Colour Chemists' Association: Sixth Technical Trade Exhibition

Owing to war damage repair work being undertaken at the Borough Polytechnic, the Sixth Technical Trade Exhibition of the Oil and Colour Chemists' Association will not be held there, as in former years,

but instead will be at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1, on the following dates and times: April 21 (3–8.30 p.m.), April 22 (2–8.30 p.m.) and April 23 (2–7.30 p.m.). One advantage of this change is that the entire exhibition will be housed in one hall. An exhibition luncheon will take place, as in former years, at the Criterion Restaurant, Piccadilly, London, W.1, on April 21, tickets (one guinea each) for this function being restricted to members of the Association and to two per exhibitor. Applications for these tickets and for copies of the exhibition brochure should be made to the General Secretary, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4, from whom all further information can be obtained.

Fourth International Conference on Electrodeposition and Metal Finishing, London

THE Fourth International Conference on Electrodeposition and Metal Finishing will be held in the Holborn Restaurant, 218 High Holborn, London, W.C.1, during April 20–24. The Conference, which is under the ægis of the International Council for Electrodeposition, will be organized by the Institute of Metal Finishing. About two dozen papers will be read, and a session of particular interest will be one at which a panel of American experts will answer questions relating to practice in the United States. An exhibition of techniques and equipment will be held in conjunction with the Conference. Further information can be obtained from the Conference Secretary at the Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

Royal Society Lectures

THE following arrangements have been made for Royal Society Lectures during 1954: Leeuwenhoek Lecture, by Prof. J. H. Quastel, professor of biochemistry, McGill University, Montreal, and director of the Research Institute, Montreal General Hospital, on "Soil Metabolism" (May 6); Croonian Lecture, by Sir Howard Florey, professor of pathology in the University of Oxford, on "Mucins and the Protection of the Body" (May 27); Bakerian Lecture, by Prof. A. R. Todd, professor of chemistry in the University of Cambridge, on "Chemistry of the Nucleotides" (June 17).

The Night Sky in March

NEW moon occurs on March 5d. 03h. 11m., U.T., and full moon on March 19d. 12h. 42m. The following conjunctions with the moon take place: March 11d. 13h., Jupiter 3° S.; March 23d. 02h., Saturn 8° N.; March 26d. 15h., Mars 3° N. Mercury is in inferior conjunction on March 1, after which it is a morning star but is unfavourably placed for observation during the month. Venus, an evening star, sets at 18h. 10m., 18h. 55m. and 19h. 45m. on March 1, 15 and 31, respectively. Most of the illuminated portion of the disk is visible, and the stellar magnitude is $-3{\cdot}4$ throughout the month. Mars, a morning star, rises at 2h., 1h. 40m. and 1h. 15m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·8–0·2. The great change in brightness is due to the decrease by 27 million miles in the planet's distance from the earth. Jupiter is visible throughout the night, setting in the early morning hours at 2h. 35m., 1h. 45m. and 0h. 50m. on March 1, 15 and 31, respectively, stellar magnitude $-1{\cdot}8$. Saturn is an evening star, rising at 23h., 22h. and 20h. 55m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·6–0·5, and is easily identified in the constellation Libra a little north-west of α Libræ. Occultations of stars brighter than magnitude 6 are as follows, observations being as if made at Greenwich: March 11d. 21h. 30·4m., 118 Taur. *f* (*D*); March 13d. 18h. 37·9m., δ Gemi. (*D*); March 13d. 19h. 44·6m., δ Gemi. (*R*); March 13d. 23h. 03·9m., 63 Gemi. (*D*); March 16d. 22h. 41·4 m., 83 B. Leon. (*D*); March 17d. 1h. 43·3m., π Leon. (*D*). *D* and *R* refer to disappearance and reappearance, respectively. Vernal equinox takes place on March 21d. 04h.

Announcements

THE essay subjects for this year's *Endeavour* prizes of the British Association for the Advancement of Science will be as follows: the upper atmosphere; heat of the earth; coal as a raw material; water supply; the span of life; and colour photography. Essays must be sent in by June 1 and must not exceed four thousand words. Competitors must be twenty-five years old or less on June 1 and the prizes will be 50, 25 and 15 guineas respectively, with two special awards of 5 guineas for those less than eighteen. Further information can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

DR. R. BRAUDE, of the National Institute for Research in Dairying, has been appointed adviser on pig research to the Agricultural Research Council. The post will only occupy part of Dr. Braude's time, leaving him free to continue active research in this field. He will also act as technical secretary to a committee which is being set up by the Council to review and co-ordinate existing research on pigs, and to propose such other work as is thought desirable.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are offering a number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering, for the academic year beginning next October. The closing date for applications is March 15. Further particulars can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1 (to whom residents in Northern Ireland should also apply), or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

THE first part of *Current Chemical Papers* has now been issued by the Chemical Society (No. 1, pp. 44; 1954) and contains the titles, with authors' names and references to the original, of publications received during the whole of the previous month. The entries are classified in ten groups and cover the whole field of chemistry. There will be no index to the publication. Further particulars can be obtained from the Chemical Society, Burlington House, London, W.1.

THE final volume of "Thorpe's Dictionary of Applied Chemistry", announced by Messrs. Longmans Green in *Nature* of February 20 (Advert. Supp. p. ii), as for publication this month, will not be ready until the early summer.

ERRATUM. In the communication "Pigmentation of the Jellyfish, *Pelagia noctiluca*" (*Nature*, January 23, p. 169, par. 7, lines 8 and 9, for "but no pyrrole reaction on roasting" read "and a pyrrole reaction on roasting".

ATOMIC ENERGY RESEARCH AT HARWELL*

THE Atomic Energy Research Establishment at Harwell is responsible for research into all the problems of atomic energy except those relating to atomic weapons, which are studied at the Armament Research Establishment under Sir William Penney at Aldermaston.

The work at Harwell is mainly applied research on the development of new types of nuclear reactors and their civil applications. Two research reactors, Gleep and Bepo, have already been built, and help was given in designing the plutonium production reactors at Risley. This work requires the solution of many chemical and metallurgical problems, and a large staff of scientists is required to study them. A by-product of the reactor programme is the manufacture of radioisotopes, and many consignments of them are now sent to assist medical, agricultural and industrial research all over the world.

Nuclear reactors are assemblies of uranium either in its natural proportions or enriched in the proportion of uranium-235, together with other materials known as moderators, in such quantities and proportions that a sustained nuclear chain reaction is established producing fissions of the light isotope of uranium at a steady rate. The moderator slows the neutrons down to thermal energies, at which they have a much greater probability of causing fission. The designer of a reactor is faced by a host of complex problems. He has to make sure that at least one, on the average, of the neutrons emitted from a nucleus undergoing fission eventually causes another fission, so that the reaction is maintained in spite of the fact that neutrons are lost by capture in the moderator and structural materials, or by escape from the reactor.

Three groups of physicists are concerned with reactor design. Theoretical workers calculate how the neutrons behave in a reactor of any specified design, and then the reactor physicists build a sub-critical reactor to confirm their predictions. The solid-state physicists estimate how well the proposed structural materials will stand up to the intense neutron bombardment inside a reactor.

The designer is very restricted in his choice of materials by the requirement that they must not capture many neutrons. The only practicable moderators are graphite, heavy water, beryllium and ordinary water. Each of these has its advantages but also its disadvantages, so the designer has to make a choice to suit the type of reactor required. Another problem is the choice of fluid to transfer the heat from the reactor to the power unit. The first British nuclear power plant will use carbon dioxide as the heat-transfer medium and graphite as the moderator.

As the reaction proceeds, the uranium-235 is destroyed by fission and almost replaced by plutonium-239 formed from uranium-238 by neutron capture. As the fission products themselves capture neutrons, there comes a time when they absorb so many that the reaction stops. It is therefore necessary that they should be removed; it is sometimes desirable also to extract the plutonium, for it has many important uses. Several groups at Harwell are studying the complex chemical and engineering problems of the extraction and utilization of plutonium and fission products. The latter used to be regarded as waste; but now many industrial uses are being found for them.

Since radiations injurious to the human body are emitted by nuclear reactors, it is necessary to study the biological effects of atomic radiations and establish strict safety regulations. This has now been done so effectively by the Health Division at Harwell that the danger of radiation injury is negligible.

Such are some of the many problems which have arisen in the development of the first power reactor in Great Britain. Each new type of reactor brings in a new set of problems, often requiring the separation of some rare metal and the determination of its chemical and metallurgical properties. Fast reactors are now being extensively studied as they are potentially important as breeders of nuclear fuel. They use no moderator, and the reacting volume is very small, which makes the heat-transfer problems more difficult to solve. Furthermore, the neutron flux is much greater in these reactors; this intensifies the problem of finding materials able to retain their mechanical properties. To assist in these studies a materials testing reactor with a very high neutron flux is being designed at Harwell to study the behaviour of materials under intense neutron bombardment.

All these technological developments depend on the researches of the nuclear physicists, who determine the fundamental nuclear constants which have to be known before a reactor can be designed. It is very important, for example, to know accurately the average number of neutrons emitted per fission of uranium-235 or plutonium, and how they react with the materials used in building the pile.

Apart from these studies directly related to reactor development, there are many research groups at Harwell working on fundamental problems, such as the nature of nuclear forces, with no immediate practical application in view. Among the instruments used is a cyclotron which can accelerate protons to 180 MeV., and a 600-MeV. proton linear accelerator is being built. The chemists have groups working on the elements beyond plutonium, on solid-state chemistry and on radiation chemistry. All this work is done in close collaboration with the universities—an arrangement which is mutually beneficial.

Many new kinds of electronic devices which are indispensable in nuclear research are being developed, and some of these are being built in large quantities by industry for other research laboratories and for civil defence. An electronic calculating machine using transistors is being built to solve the computing problems of the theoretical physicists.

Harwell is organized into a number of divisions, each dealing with one aspect of atomic energy and composed of up to ten research groups each studying a particular problem. The work of the different groups and the focusing of the research on to special projects is arranged by a number of committees or informal working parties. Every effort is made to avoid excessive formalities and in this the administrative staff has co-operated very fruitfully.

* Summary of a lecture by Sir John Cockcroft, being the first of a series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London. The complete series of six lectures will appear in the March and subsequent issues of the *Atomic Scientists' Journal*, and also as a book entitled "News and Views on Atomic Energy", to be published by Messrs. Taylor and Francis, Ltd.

MICRORADIOGRAPHY AND AUTORADIOGRAPHY

A SYMPOSIUM on microradiography and autoradiography was held on December 17, 1953, at the Institute of Physics, 47 Belgrave Square, London, by the Scientific and Technical Group of the Royal Photographic Society. Many modern scientific methods are intimately connected with photographic techniques, and it can be regarded as very fortunate that biological and medical research workers and photographic scientists were able to meet one another at such an occasion to discuss their methods and also their results.

The first part of the meeting was devoted to microradiography and gave evidence of the potentialities and limitations of the method. From recent physical and technical developments on X-ray beams from very small focal spots, new possibilities may be expected. The first speaker, Prof. G. A. G. Mitchell (Anatomy Department, University of Manchester), explored the potential uses of microradiography of biological objects, such as body tissues, leaves, seeds, fibres, hairs, insects, wings, ova, small crustacea, etc. He has tried methods of enhancing contrast by using various injections and by soaking or impregnating tissues and materials with solutions which are more-or-less radio-opaque; he has also tested material with and without preliminary freeze-drying. Prof. Mitchell came to the conclusion that in most respects microradiography is less valuable than histological and histochemical methods in investigating the structure and composition of biological objects. On the other hand, the following advantages of microradiography were stressed: much thicker sections can be examined and thus the arrangement of various structures can be traced over greater distances than is possible in ordinary histological sections 5–10 μ thick; structures containing bone or calcareous deposits can be examined without preliminary decalcification; normal or abnormal deposits of radio-opaque substances are readily detectable; and the distribution of vessels and tubules can be studied accurately and fairly rapidly by the method.

Mr. R. V. Ely (London) dealt almost exclusively with the requirements of apparatus such as 'sealed off' and 'demountable' X-ray tubes, backing and diffusion pumps, valves, vacuum gauges, high tension and filament supply units, mains voltage stabilizers, vacuum cassettes, etc. A demountable X-ray tube developed by Mr. Ely permits easy removal of the window in order to attach an extension cylinder holding a quarter-plate at a considerable distance from the target. The apparatus can be used for photographic as well as for direct magnification; in the latter case only very small focal spots are permitted.

Whereas the first two speakers chiefly dealt with magnifications up to 500 times, the third speaker, Dr. V. E. Cosslett (Cavendish Laboratory, Cambridge), looked for magnifications of the order of one thousand diameters and above. He therefore prefers the term 'X-ray microscopy' to microradiography. Since the optical resolving-power is limited to about 0·5 μ by the wave-length of light, a higher resolving-power should be possible using X-rays of a wave-length of the order of 1 A. As the contrast attainable is roughly proportional to the cube of the wave-length of the X-rays, practical considerations demand the use of wave-lengths of one or several angströms (that is, 12-kV. X-rays and less are required). Four basic methods of X-ray microscopy were suggested: the conventional contact method, where object and film are in close proximity; three other methods which entail direct magnification by means of curved crystals, by mirror reflexion and end-window X-ray tubes, respectively. The relative merits of these four methods were reviewed, and the end-window technique that has been developed by Dr. Cosslett was described in greater detail. It involves the production of an ultra-fine focus on an end-window target, using electron optical techniques. The use of very thin windows makes high X-ray intensity available from spots of the order of 1 μ in diameter. At present, Dr. Cosslett and his co-workers are attempting to obtain a focal spot of the order of 0·1 μ. High direct magnification is obtained by bringing the specimen close to the window. Several examples of Dr. Cosslett's method for examining the microstructure of biological and metallurgical specimens were shown. Photographs have been taken of living insects, in which great interest is being shown at the present time, in order to follow up radiation damage in insects when exposed to various X-ray doses.

The second part of the meeting was entirely devoted to biological autoradiography. The techniques of micro-autoradiography are mainly based on the use of stripped nuclear-track emulsions. At present the refinement of methods appears to be in the foreground of autoradiographic investigations and, in particular, a deeper insight into the problems of resolution and quantitative uptake of radioisotopes is required. Dr. S. R. Pelc (Experimental Radiopathology Research Unit, Hammersmith Hospital, London) reviewed autoradiography by discussing the possibilities and limitations of the method, the planning and design of experiments and the interpretation of the results. The incorporation of radioisotopes into chemical compounds in the organism depends on the correct choice of the chemical compound of interest and the concentration, which in turn is dependent on the sensitivity of the film material to be used. Formulæ which relate the concentration in terms of micro-curies per c.c. and of half-lives of the tracer were given. An estimate of the amount required depends also on the frequently unknown distribution within the organism. It was shown, for example, that, by administering sulphur-35 as sulphate ion, it finds its way into the cells of the cartilage of the trachea and very little is taken up by the epithelial lining. After injection of sulphur-35 as *dl*-methionine (^{35}S), significant accumulation of the isotope is found in the epithelial cells and only a faint trace in the cells of the cartilage. In the preparation of the specimens, special care has to be taken in regard to possible loss of radioactive compounds due to solvents and also to the possibility of the formation of artefacts that are caused, for example, by chemical interaction between specimen and photographic material. Several examples of the possible ambiguity and pitfalls in interpretation were given.

Dr. L. F. Lamerton (Department of Physics, Royal Cancer Hospital, London) discussed problems involving the resolution and sensitivity in autoradiography. In contrast to the theoretical treatment of resolution by Doniach and Pelc, Dr. Lamerton defines resolution as the distance d if the images of two uniformly active cylindrical sources of diameter d can just be resolved when the centres are separated by a distance $2d$. A table was given showing the resolution, in terms of microns, obtainable theoretically for various emulsion and specimen thicknesses

and for various distances between specimen and film. In addition there are two further factors which limit the high resolution otherwise attainable. These are the unavoidable background due to chemical fogging and cosmic rays, and the cross-fire of radiation from surrounding parts of the specimen. With reasonable precautions, the background may be reduced to about 4 grains/100 μ^2 or less. From a theoretical treatment of the cross-fire radiation (based on a relation between grain density and distance from a point source), it is shown that an autoradiograph will be recognizable above a structure of cellular dimensions only if the concentration of the activity within the structure is a number of times greater than that of the surrounding specimen. This concentration must be higher for long-range electrons, that is, greater with phosphorus-32 than with sulphur-35 or carbon-14. Dr. Lamerton referred also to a new Kodak X-ray stripping-plate which fills the gap in sensitivity and resolution between the fast X-ray film and the relatively slow nuclear-track stripping-plate.

Dr. L. G. Lajtha (Radiotherapy Department, Churchill Hospital, Oxford) described a high-resolution autoradiographic stripping-film technique adapted to smears made from human bone-marrow cultures *in vitro*. In such a smear the cells are separated sufficiently from each other to prevent 'cross-fire', and good results have been obtained by floating the emulsion at 25° C. on distilled water for 4–6 min. The autoradiographs were stained after processing to facilitate recognition of the individual cells. The method is sensitive enough to detect and localize as little as 20–30 phosphorus-32, or 30–50 sulphur-35, atoms per cell.

Experiments on the mechanism of deoxyribonucleic acid synthesis as measured with phosphorus-32 and adenine (^{14}C) were described. Experiments on sulphate (^{35}S) uptake have shown that uptake of inorganic sulphate (^{35}S) and its incorporation into a substance related to the chondroitin sulphates is a specific function of the myeloid cells in the bone marrow.

THE BOSE INSTITUTE, CALCUTTA

THE thirty-sixth anniversary meeting of the Bose Institute took place on November 30, 1953, when Dr. N. K. Bose, director, River Research Institute, delivered the sixteenth Acharya Jagadish Chandra Bose Memorial Lecture on "The Role of Silt and Sand in Multipurpose River Valley Projects".

Dr. D. M. Bose, director of the Bose Institute, in presenting his report on the working of the Institute for the past year, said that completion of many important projects commenced during the past few years was being delayed for want of funds. He mentioned that early this year the Institute had acquired a plot of forty bighas of good agricultural land at Shamnagar, near Barrackpur, for erection of an experimental station for certain fundamental investigations in plant sciences which the Institute proposes to undertake. The Institute had to obtain a loan of Rs. 60,000 for this purpose. For the erection of necessary residential quarters and laboratory buildings and for electric installation and for fencing the estate about Rs. 1 lakh will be required.

The investigations which the Institute has been carrying out during the past few years on the action of X-radiation in producing mutations in a few economic plants have obtained a certain amount of recognition, and the Institute has, on invitation from the National Institute of Sciences of India, submitted a five-year scheme, which may be extended by another five years, of fundamental investigations on the mutagenic action of different kinds of radiations on plants. The latter will be selected mainly for their suitability for genetic studies.

Preliminary investigations started during the past year have disclosed that the beta-radiation from radioactive phosphorus, which is selectively absorbed in plant nuclei, is a very convenient tool for inducing mutation in plants; for example, with this method, new types of effects are being obtained in certain varieties of jute plants in addition to those obtained with the same kind of plants after irradiation trials with X-rays extending over many years.

At Mayapuri, Darjeeling, a plant pathological laboratory was begun about three years ago as an experimental measure. Already valuable work has been started on the breeding of new hybrids of potatoes resistant to several virus and fungal infestations, using locally available potatoes as one of the parents and imported resistant strains as the other. This work is being undertaken in co-operation with the West Bengal Seed Potato Farm at Rungbul, near Darjeeling. The Institute has already done some good work in detecting the presence of potato wart disease, hitherto not known to occur in India, in one of the plots at Rungbul sown with an imported variety of potatoes known as Furore. This observation when published in *Science and Culture* attracted the attention of the Ministry of Agriculture, Delhi, and resulted in a visit to Darjeeling of the director of potato research and the deputy director of plant protection for inspection of control measures. Studies of other potato disease of bacterial origin have resulted in the receipt for examination from different parts of India of similar infected potato tubers. Without more financial assistance the Institute cannot indefinitely maintain the Plant Pathological Laboratory, which will be compelled to close.

Mayapuri is also being developed as a centre for cosmic ray research. On a request from the Council for Scientific and Industrial Research, India, a scheme with detailed plans and estimates for erection of a laboratory and workshop for cosmic ray research has been submitted. There will also be accommodation for guest workers who may come to Mayapuri for cosmic ray work.

The Institute has received a new grant from the Board of Research on Atomic Energy for investigations on the use of radioactive isotopes of carbon and phosphorus for studying photosynthesis and the mutagenic action of beta-rays of phosphorus. In a recently formulated five-year plan of research the Institute has included a proposal for the study of photosynthetic utilization of solar rays as a method for food and power production and of its economic feasibility.

The microbiology department has received a grant from the Council for Scientific and Industrial Research, India, for the production of antibiotics isolated from *Streptomyces* spp. which has some remarkable bactericidal properties.

Besides these new schemes, the Institute is continuing to receive the usual grants-in-aid from the Board of Research on Atomic Energy, the Central Jute Committee, the Central Oil Seeds Committee, the Cotton Committee of West Bengal, I.C.A.R. grant for weed control, and the B.O.C. grant for palæobotanical research.

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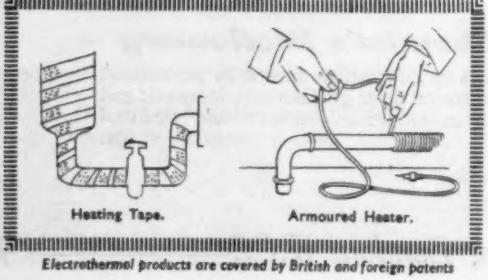

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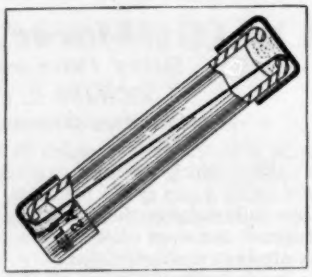

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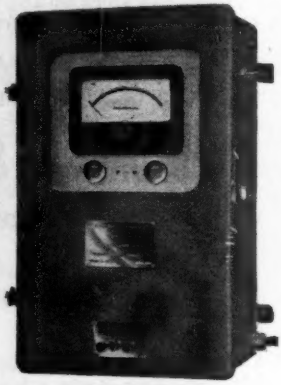

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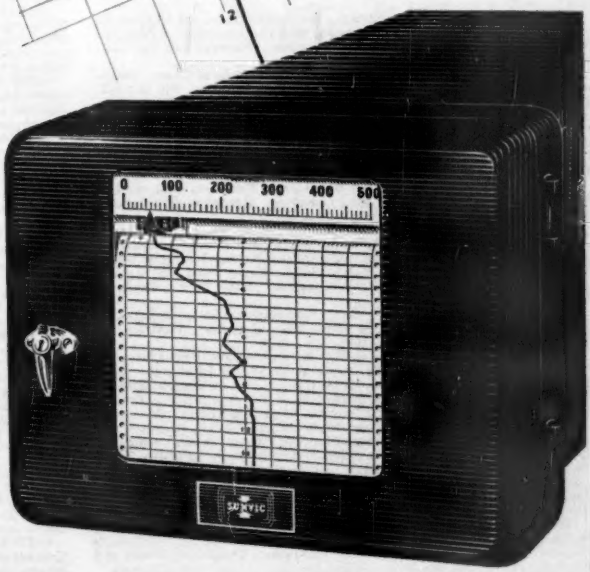

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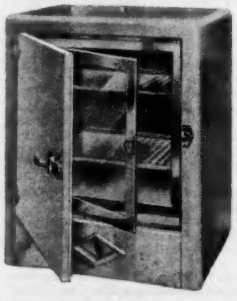

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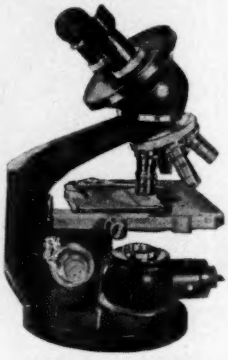

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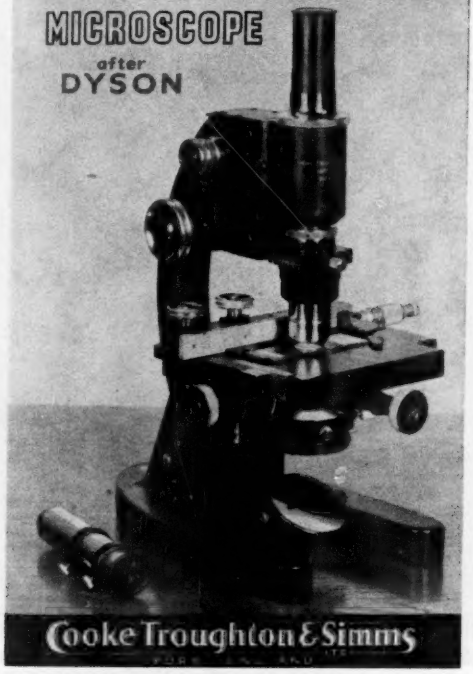

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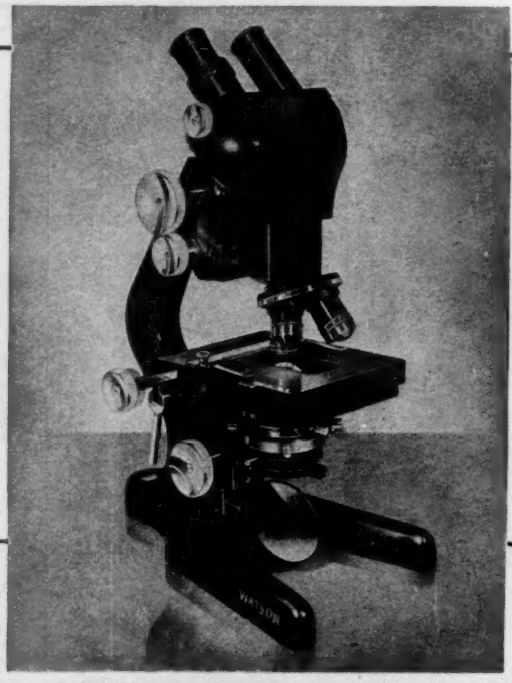

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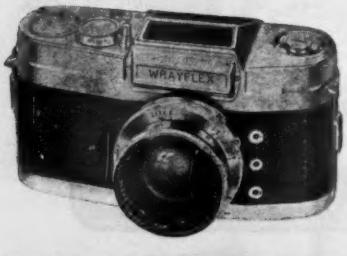

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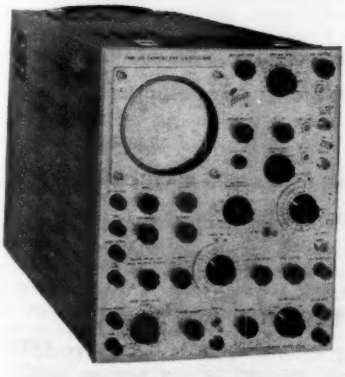

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COUNTY DETAILS OF THE CENSUS OF WOODLANDS, 1947–49

THE Forestry Commission Census Reports, Nos. 1 and 2, dealing respectively with the woods less than and more than five acres in extent (the latter including hedgerow and park timber) have already been reviewed in *Nature* (August 8, p. 240, and October 3, p. 616), and they have now been supplemented by three further issues—Census Reports Nos. 3, 4 and 5—giving the details for the Welsh, Scottish and English counties respectively as deduced from the Census of Woodlands 1947–49*. The details are given by counties for these larger woods, the additional figures being for areas only, as the information is not available for standing volume or annual growth. Distribution as between the Forestry Commission and Private Woodlands is shown in all the nine tables given in standard form for each county. National totals are usefully given even where this means some duplication of information given in Report No. 1.

In addition to showing the break-down of the totals of Report No. 1 into county figures, fuller detail is given in certain other respects. Thus the age-class structure of the several categories of high forest is shown by decades for 0–40 years and by twenty-year periods between 40 and 80 years, followed by two classes for the older woods, namely, 80–120 and more than 120 years. This detail will be useful for many purposes owing to the big differences in immediate utility, rate of growth, current yields as thinnings, etc., between crops of different age, which are such that the grouping into only two classes above and below 40 years is inadequate.

The fuller detail for the areas under the different tree species is similarly very necessary since the distribution is so widely different from county to county—and here, too, age-classes are differentiated, while separate tables are given for pure stands only as well as for mixed and pure stands together. Thus the basic data are now available for determining what area of spruce or poplar might be available in any section of the country from which to draw supplies for existing or contemplated industries.

Information is also given for six more of the less commonly grown conifers and six more hardwoods, revealing how little we still have of them, even of poplar (1,466 acres, though this is only for woods more than five acres in extent). It can similarly now be seen where the scrub and devastated woodlands are concentrated and how much of these areas is thought to be suitable for economic management.

These reports are in foolscap size, the counties being arranged in alphabetical order, and the tables are reproduced in a clear and convenient form so that reference is easy. The only regret is that one has to be content with area data where one usually needs volumes.

H. G. CHAMPION

* Forestry Commission. Census of Woodlands 1947–49: Woods of Five Acres and Over. Census Report No. 3, Welsh County Details; pp. viii+90; 4s. 0d. Census Report No. 4, Scottish County Details; pp. vii+187; 10s. 0d. Census Report No. 5, English County Details; pp. vi+270; 12s. 6d. (London: H.M.S.O., 1953.)

OXIDATION OF PHENYLHYDRAZINES IN THE PRESENCE OF OXYHÆMOGLOBIN AND THE ORIGIN OF HEINZ BODIES IN ERYTHROCYTES

By DR. G. H. BEAVEN

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Department of Pathology (Hæmatology), Postgraduate Medical School of London, W.12

THE occurrence in phenylhydrazine ($Ph.NH.NH_2$) poisoning of a hæmolytic anæmia with Heinz inclusion bodies in the erythrocytes is well known. Such inclusions also form rapidly in normal erythrocytes on *in vitro* incubation at 37° with phenylhydrazine[1]. With destromatized oxyhæmoglobin solution and excess of various substituted phenyl hydrazines, the oxyhæmoglobin is degraded and precipitated as a 'green hæmoglobin' with composition similar to that of the Heinz bodies, while the hydrazine undergoes oxidation. The process is strictly aerobic, though at low oxygen tension other changes in the oxyhæmoglobin may occur with the more reactive hydrazines, such as choleglobin formation without any formation of green precipitate. The aerobic oxidation of long-chain, unsaturated fatty acids is also catalysed by oxyhæmoglobin, which is decomposed and converted to colourless substances[2]. In these reactions, oxyhæmoglobin is "the catalyst of its own destruction"[3], while acting as the last link in the utilization of molecular oxygen[4].

Oxidation of Arylhydrazines

Experiments were performed in Dreschel bottles, and volatile products of oxidation swept over by air or oxygen into ethanol. In the presence of oxyhæmoglobin, excess phenylhydrazine and acetylphenylhydrazine (Ph.NH.NH.COMe) yield as end-products nitrogen and benzene, the latter being detected by its ultra-violet absorption spectrum.

When present in excess, the oxyhæmoglobin is itself oxidized to methæmoglobin (MetHb), and with 2 : 4-dinitrophenylhydrazine and *asym*-diphenylhydrazine this reaction alone occurs, no green hæmoglobin being formed.

Benzene is not formed from phenylhydrazine or acetylphenylhydrazine in the presence of reduced hæmoglobin (Hb) and nitrogen, and similarly with methæmoglobin only a trace of benzene is formed, but a much larger production occurs on admission of oxygen. With oxyhæmoglobin, less benzene is formed under anaerobic than under aerobic conditions. Spectroscopic evidence suggests that reduction of oxyhæmoglobin or methæmoglobin precedes degradation. Similar aerobic reactions, with insoluble 'green hæmoglobin' production, occur with phenylhydrazine-*p*-sulphonic acid; with *o*- or *p*-nitrophenylhydrazine, the volatile oxidation product is nitrobenzene.

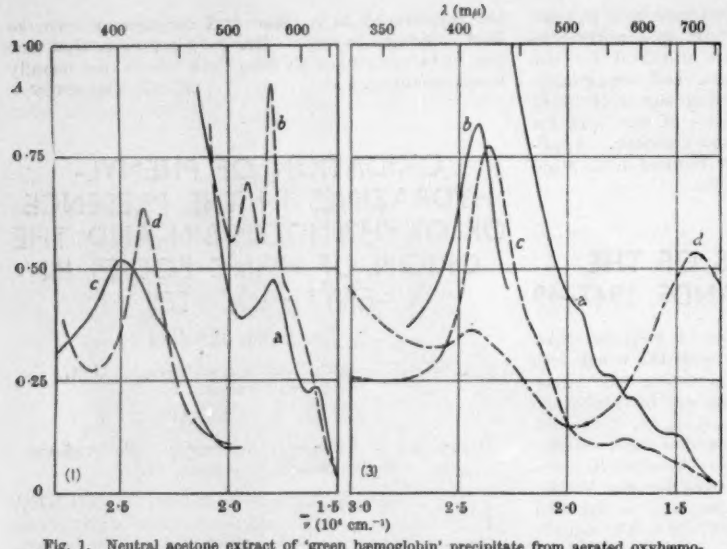

Fig. 1. Neutral acetone extract of 'green hæmoglobin' precipitate from aerated oxyhæmoglobin – acetylphenylhydrazine system. (*a*) ———, Neutral acetone extract, diluted 1 : 10; (*b*) – – –, neutral acetone extract diluted 1 : 10 with 30 per cent aqueous pyridine, followed by dithionite

The two curves have been separated slightly on the absorbance scale for increased clarity (*c*) ———, As (*a*), diluted 1 : 100; (*d*) – – –, as (*b*), diluted 1 : 100

The scales of all the figures are linear in wave-number ($\bar{\nu}$) and absorbance (optical density)

Fig. 3. (*a*) ———, Iron-free green pigment from acid-treated 'green hæmoglobin' precipitate in chloroform; (*b*) ———, as (*a*), diluted 1 : 5; (*c*) – – –, as (*b*), in 20 per cent hydrochloric acid; (*d*) –.–.–., blue-green 'biliverdin-type' pigment from acid-treated 'green hæmoglobin' precipitate, in 30 per cent aqueous pyridine

Arylhydrazines are readily oxidized by atmospheric oxygen[5], but only traces of benzene or nitrobenzene have been obtained from aerated aqueous suspensions of phenylhydrazine or *p*-nitrophenylhydrazine. These findings point to an oxidation-reduction system between the oxyhæmoglobin and the arylhydrazine, with hydrogen transfer from the latter to molecular oxygen, while the oxyhæmoglobin undergoes irreversible changes. The oxidation of acetylphenylhydrazine by potassium ferricyanide is also catalysed by oxyhæmoglobin with appreciable production of benzene and conversion of the pigment to 'green hæmoglobin' precipitate.

The oxidation by molecular oxygen may involve hydrogen peroxide, but the rate of oxidation of acetylphenylhydrazine does not appear to be affected by 0·0025 *M* potassium cyanide added to depress catalase activity. (S. Brenner and A. C. Allison (*Experientia*, **9**, 381; 1953) have since pointed out, however, that many toxic substances producing Heinz bodies are themselves catalase inhibitors, and suggest that catalase inhibition may be the first step in the production of Heinz bodies in intact erythrocytes.) The system arylhydrazine/oxyhæmoglobin possesses certain similarities to the aerobic phenylhydroxylamine/oxyhæmoglobin system of Keilin and Hartree[6], in which nitrosobenzene is formed and co-ordinates with the hæm of the hæmoglobin. When oxyhæmoglobin is aerated in the presence of excess nitrosobenzene, we find that the purple complex decomposes and a typical 'green hæmoglobin' precipitate forms.

The intermediate products have not been characterized in our work, with the exception of phenol. Benzene is the ultimate product of oxidation of phenylhydrazine or acetylphenylhydrazine, possibly arising via the diimide PhN=NH[7], but the yield is small under our conditions.

The 'Green Hæmoglobin' Precipitates

The insoluble 'green hæmoglobin' is complex, containing hæms and other iron-containing pigments bound to denatured globin. The relationship to choleglobin and denatured choleglobin hæmochrome[8,9] is not clear; the former can often be detected, but may not be related directly to the formation of the 'green hæmoglobin', and indeed is most abundant in poorly-oxygenated systems where no green precipitate is formed. Certain features of the green precipitate formed in the presence of acetylphenylhydrazine have been clearly established:

(1) Neutral acetone extracts a hæm with bands at 400, 557 and 625 mμ (Fig. 1), giving a typical

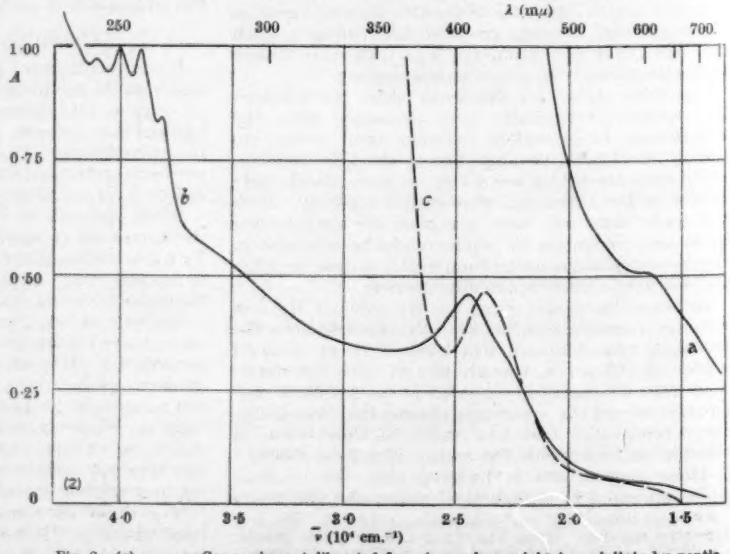

Fig. 2. (*a*) ———, Green pigment liberated from 'green hæmoglobin' precipitate by peptic digestion, in water; (*b*) ———, 1 : 5 dilution of (*a*); (*c*) – – –, solution (*b*) after dithionite

hæmochrome spectrum with pyridine and dithionite with maxima at 418, 525 and 557 mμ. More hæm is extracted by acid acetone.

(2) The hæm is a protohæm, since protoporphyrin and mesoporphyrin (ratio *c.* 10 : 1) are the only porphyrins isolated after treatment of the 'green hæmoglobin' with sodium amalgam. Normal hæmoglobin gives the same porphyrins in similar ratio under these conditions[10], but in much higher yield.

(3) Protein-bound hæm is most abundant during the early stages of the formation of green precipitate, when the colour is predominantly brown-green. Later, the hæmochrome reaction is weaker, but iron-containing green pigments are still present. Secondary changes lead to very firm binding of the pigments to the protein, so that acid acetone no longer extracts them completely, and the precipitate loses its solubility in aqueous urea solution, though remaining soluble in glacial acetic acid.

(4) The green pigments are liberated as water-soluble peptides by peptic digestion. A Soret-type absorption band occurs (Fig. 2) at 410 mμ, moving to 423 mμ on dithionite reduction. An inflexion at 605 mμ is the only other feature in the visible region. Ferric iron is rapidly liberated from the green pigment in 2·5 *N* hydrochloric acid (cf. ref. 11), leaving chloroform-soluble green pigments which still possess an absorption band at 410 mμ (Fig. 3).

(5) Derivatives resembling verdohæmochrome[3,12] were not obtained. None the less, the presence of acid-labile iron and the persistence of a Soret-type absorption band suggests that the porphyrin ring has not been opened, and that the protein-bound green pigment is not of the bile-pigment type. Most attempts to obtain bile pigments from the green precipitate, either directly or after treatment with hydrochloric acid or acetic acid, have failed. However, on one occasion hydrochloric acid – acetone extracted a blue-green pigment with biliverdin-type band at 705 mμ, but an anomalously weak band at 410 mμ (Fig. 3).

Heinz Body Anæmia

The relationship of the 'green hæmoglobin' precipitate to Heinz bodies in erythrocytes was studied in a case of poisoning by acetylphenylhydrazine, and also in erythrocytes incubated with this compound. Heinz bodies remained attached to the stroma after laking the erythrocytes. Denatured globin was demonstrated by staining after susa fixation in a mixture of orange *G* and aniline blue at *p*H 3; the bodies stained orange, as does the hæmoglobin in intact erythrocytes, whereas the stromal protein was blue[13]. Stromal lipoid, which stained with sudan black, was present at the periphery of the bodies.

Repeated washing of the residue after laking yielded a brownish-green mass of Heinz bodies. Pyridine extraction gave the pyridine hæmochrome spectrum ($\lambda_{max.}$ 418, 525 and 557 mμ), intensifying with dithionite. Extracts with 0·1 *N* hydrochloric acid, ethanol and 0·2 *N* potassium hydroxide had Soret-type absorption bands at 398, 402 and 407 mμ respectively. The soluble oxyhæmoglobin from the patient's erythrocytes was normal and no methæmoglobin or choleglobin was detected.

In the various extracts of experimentally produced 'green hæmoglobin' precipitate, benzene was frequently detected (Fig. 2). It is noteworthy that in anæmia of swine caused by phenylhydrazine, Lawrason *et al.*[14] observed typical hæmolytic anæmia in five animals, but a fatal aplastic anæmia in the sixth, the features of which resembled benzene poisoning.

We wish to thank Dr. E. R. Holiday for spectrographic facilities and Dr. E. A. Johnson for assistance with some of the experimental work.

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INFLUENCE OF TEMPERATURE AND SOIL WATER CONTENT ON THE SEEDLING BLIGHT OF MAIZE

By JOHN L. HARPER
Department of Agriculture, University of Oxford

IN northern temperate climates, a serious problem in maize cultivation is that the growing season is usually too short to allow the grain to ripen[1]. It is therefore desirable to plant as early as possible. However, early plantings seldom give a good stand because in the germination phase the grains are attacked by pathogenic fungi. Varieties of maize differ in their resistance to this 'seedling blight' and a variety of laboratory techniques have been devised to assess the resistance of newly bred varieties. These tests usually involve planting the grain in jars or trays of soil, which are then exposed to low temperatures, usually between 7° and 10° C. for a period of 8–10 days. After this treatment the grain is allowed to germinate at some favourable temperature, usually 20–25° C. The proportion of grains which fail to germinate gives a measure of the resistance to seedling blight or what is sometimes loosely called 'cold hardiness'[2].

The length of the exposure and the temperatures to which the grains are subjected vary from worker to worker, and apart from the pioneer work of Dickson[3], who studied infection by *Gibberella zeae*, there has been no previous attempt to investigate in a detailed manner the comparative effects of exposure to different temperatures or to determine the influence of soil moisture content on the liability of maize grains to pathogenic attack in the soil. It was felt that a study of the conditions affecting seedling mortality of maize might give some information on the general behaviour of soil-borne pathogens at various soil moistures and temperatures.

For these experiments one variety of maize was used, namely, Virginian White Horsetooth, which is grown fairly widely as a forage crop in Great Britain and which was known to be liable to damage in cold

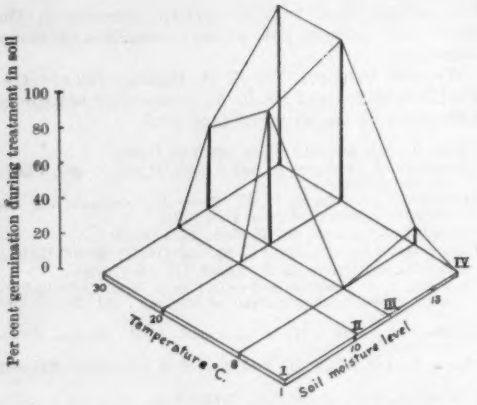

Fig. 1. The germination of White Horsetooth maize in soils of various moisture contents and at various temperatures
Soil moisture level in Figs. 1 and 2 is expressed as percentage increase in weight of dry maize grains after incubation in soil at 20° C. for 24 hr.

springs. Soils for this experiment were sampled from plots on which maize had been grown for two years previously. After collection in the late summer the soil was spread on a clean barn floor and turned every day for five days and then divided into four parts. To one part enough water was added to bring the soil to its sticky point. The amount of water needed to do this was measured, and a half and a quarter of this amount were added to two of the remaining samples. The fourth sample was maintained dry. Each soil sample was well mixed and allowed to stand for six hours to allow the water to be evenly distributed. Each sample was then mixed again, and sub-samples were placed in 1-lb. jam jars and sixteen maize grains were planted in each jar. Eighty of these jars were prepared, twenty from each soil sample, and each set of twenty was distributed at random between four incubators at 1°, 8°, 20° and 30° C. For each soil moisture/temperature combination there were five jars, and one of these was withdrawn after 3, 6, 9, 12 and 15 days. After treatment the grains were removed from the soil, first washed in 1/1,000 mercuric chloride and then in changes of distilled water and placed individually on agar slopes of maize meal agar. The tubes were now incubated at 20° C., and after fourteen days incubation the number germinated was recorded (a seed was said to have germinated if the main root had emerged from the sheathing coleorhiza). Germination was tested in this experiment on agar slopes so that the types of fungi invading the grains could be investigated; but these particular results of the experiment will be published elsewhere. A series of controls was prepared in which grains taken directly from the original sack were surface washed as in the experimental samples, and placed directly on agar slopes.

The moisture content of the soil was determined by placing weighed samples of maize grains in additional jars of the soil samples, and after twenty-four hours incubation at 20° C. the grains were removed, cleaned with a dry cloth and reweighed. The increase in weight of the grain samples gave a measure of the availability of the soil moisture and is comparable with the method described by Shull for using seeds in the determination of the 'surface forces' of the soil[4]. For the determination of soil moisture, grains of Wisconsin 275 maize were used, as this variety gave very consistent values. Losses in weight of the grains due to respiration in the twenty-four-hour incubation period were negligible in comparison with the experimental error.

When the treated jars were sampled, it was found that many of the grains had germinated in the soils at high temperatures and moisture contents. The mean percentage germination over all sampling occasions is shown in Fig. 1.

The grains which had not germinated in the jars at the time of sampling were transferred to agar slopes at 20° C. and the subsequent failure to germinate was determined; the mean results over all sampling occasions are given in Fig. 2. Analysis of variance of the results of this experiment show that both time and soil water content have significant effects on the mortality ($P < 0{\cdot}01$). The effect of temperature as a main effect was not significant. However, the interaction of temperature and soil moisture was highly significant ($P < 0{\cdot}001$); other interactions were negligible. Clearly, soil moisture is of overriding importance in determining the extent of mortality, and the effect of temperature is mainly to produce an interaction with this main effect. Inspection of Figs. 1 and 2 shows clearly that damage is least where the treatments result in rapid germination. The greatest mortalities are obtained when the temperature and moisture conditions are such that germination just fails to take place. From this pattern of results it is concluded that the pathogens are affected in the same general manner as the host, but are more tolerant in both moisture and temperature requirements.

It is of interest that the two peaks of greatest damage, 8° C. at moisture content IV and 30° C. at moisture content II, were formed at very different rates. At 30° C. maximal damage had been attained by the sixth day; but at 8° C. the degree of injury was small at first but was still increasing after fifteen days. It is probable that the slowing up of the rate of kill is an indication of the rate at which the soil dried. (Determination of the soil moisture content of the soils after fifteen days showed that the soils had lost water during the experiment, but the relative moisture contents of the samples were scarcely changed except where rapid germination had occurred.)

The results of this experiment have an especial significance in a programme of maize breeding in

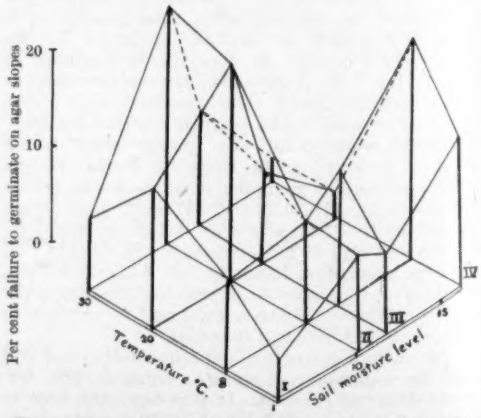

Fig. 2. The influence of various soil moisture and temperature combinations on the viability of maize grains

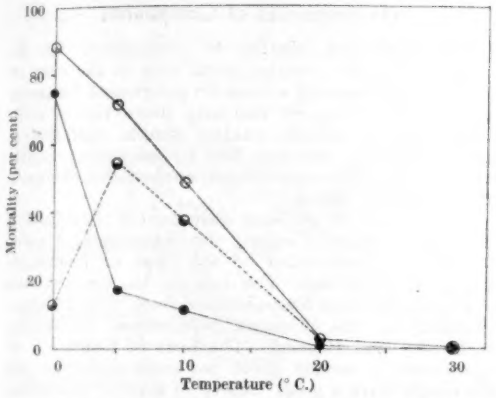

Fig. 3. The influence of fungicide seed dressing on the viability of maize grains exposed to various temperatures in wet soil. ●——●, Treated with fungicide; ○——○, not treated with fungicide; ●- - - -●, reduction in mortality due to fungicide treatment

which the cold testing of varieties is undertaken. Hitherto little attempt appears to have been made to control the moisture content of the soils employed, and it is our experience that this is the most important single factor which will influence the reaction of the varieties under test. Owing to the grave difficulties involved in maintaining a known and constant soil suction pressure, it is suggested that this cold testing should be undertaken in loosely packed soils, in open-bottomed fibre pots 6 in. tall, which stand in shallow trays of water throughout the experimental period.

In a further experiment a wide range of temperatures was employed, while, in addition, the effects of seed dressing with a commercial preparation of tetramethyl thiuram disulphide were included. The soil water content was maintained by the method previously described. Samples of White Horsetooth maize grains with and without previous seed dressing were sown in open-bottomed pots of soil standing in trays of water ½ in. deep and incubated at 0°, 5°, 10°, 20° and 30° C. After ten days treatment the pots were all transferred to a temperature of 20° C.; the ultimate germination (inclusive of that during and after treatment) is presented in Fig. 3. It is clear that mortality decreases steadily with a rise in temperature from 0° to 20° C. and that the subsequent rise in temperature to 30° C. has little further effect. The extent of mortality prevented by fungicide dusting increases from 0° to 5° C. and then falls off and becomes negligible at 20° and 30° C. This experiment therefore allows a distinction to be drawn between the damage due to micro-organisms and that which may be called a true cold injury.

These experiments demonstrate clearly that the 'cold test' for maize must be carefully controlled if important and hitherto little-studied variables are to be eliminated. They also make it clear that a cold test of the rigid form used in these experiments could be of the greatest value in assessing the merits of fungicides.

I am grateful to Prof. G. E. Blackman for his interest in this work and his stimulating criticism.

[Dec. 24.

[1] Bunting, E. S., and Blackman, G. E., *J. Agric. Sci.*, **41**, 271 (1951).
[2] Wernham, C. C., Pennsylvania Ag. Exp. Sta. Prog. Rep., **47** (1951).
[3] Dickson, J. G., *J. Agric. Res.*, **23** (II), 837 (1923).
[4] Shull, C. A., *Bot. Gaz.*, **62**, 1 (1916).

THE PERIODIC TABLE AND ITS APPLICATIONS

By Dr. S. I. TOMKEIEFF

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THE fundamental structural pattern of the periodic table of the elements is a network composed of two sets of lines corresponding respectively to periods and groups. This network is the result of the transformation of the linear array of elements, arranged in order of their atomic numbers into a bi-linear combinatorial system, with one set of lines corresponding to cut segments of the original linear array, and the other to similar periodic terms. The points of intersection of the lines of the network correspond to elements, but because of the unequal length of the periods not all these points are occupied. Actual geometrical distances between the nodal points occupied by the elements are of no significance, as we are dealing here with a network in which incidence (position) is the important factor and not congruence (measure). The real metric of the periodic table is the electron-distance. The group lines in each period are separated by one electron-distance, the consecutive period lines by one 'core-electron number' distance.

The fact that the periodic table is a topological combinatorial system, based on incidence, means that it can be distorted or projectively transformed as long as the collinearity of points and the concurrence of lines remain invariant. In this way we can have many types of the periodic table, all projectively related among themselves and all topologically equivalent. The usefulness of any given form of the periodic table depends on its degree of conformity to certain requirements. It should demonstrate the periodicity of the structure and the properties of the elements, it should be continuous, it should be completely visible and it should mirror the structure of the atom. The three principal types of the periodic table satisfying all or some of these requirements are: (1) rectilinear (Newlands, 1864; Mendeléeff, 1869), (2) helical (Béguyer de Chancourtois, 1862) and (3) spiral (Baumhauer, 1870).

Periodicity is possessed by all these three types; but type 1 lacks continuity, while type 2 lacks perfect visibility. Type 3, the spiral periodic table, clearly possesses the first three requirements and it will later be shown to possess the fourth. It is also admirably suited for service as a co-ordinate network for the purpose of contour mapping, and the main purpose of this article is to demonstrate this particular fact.

The periodic spiral used in this article is a modification of B. K. Emerson's "Helix Chemica" (1911). This shows clearly the contrast between the short and the long periods. In its present modification geochemically important elements—carbon and silicon—are placed in a central position.

The method of mapping over the periodic spiral used as a co-ordinate net is the normal cartographic method for contour maps, the data being any kind of numerical values associated with the elements. These data may be grouped under three heads: (1) properties of elements; (2) properties of compounds; and (3) composition of aggregate bodies. Such a geometrization of tabular values offers many advantages. These maps allow us to survey the distribution of the values of any measurable single

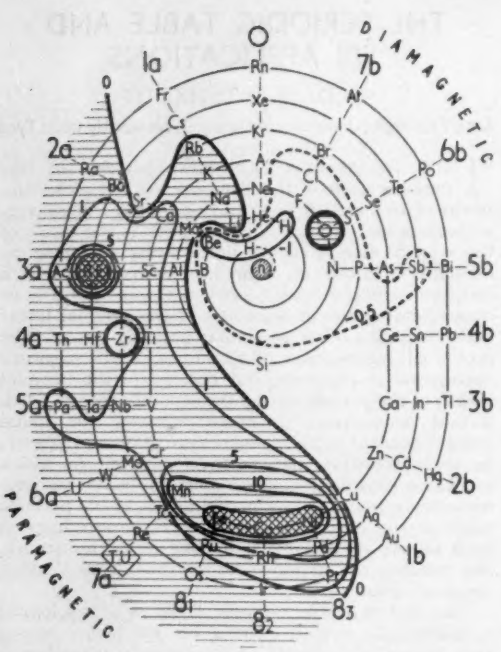

Fig. 1. Map of the magnetic susceptibility surface

property among the elements, to correlate properties among themselves and with the structure of the atom, and finally, to study the composition of aggregate bodies and to compare these with one another.

In what follows I have tried to show briefly some of the possible uses of the three principal types of maps.

(1) Properties of Elements

Maps of surfaces representing the distribution among the elements of such properties as electronegativity, ionization energy, specific gravity, atomic volume, melting point, boiling point and atomic and ionic radii are to be published elsewhere. So, for the purpose of illustrating the method of cartography, I have selected the map of magnetic susceptibility. The data for the construction of this surface have been obtained from Prof. L. F. Bates's "Modern Magnetism", and all figures refer to measurements taken at or near normal temperature. Describing these surfaces, I will use freely geographical analogies as being generally understood.

The map of the magnetic susceptibility surface (Fig. 1) shows that, with two exceptions (zirconium and oxygen), all the elements are localized within two distinct and separate areas, namely, the paramagnetic 'highlands' and the diamagnetic 'lowlands'. Zirconium forms a 'tarn' in the 'highlands', while oxygen forms a considerable 'peak' in the 'lowlands'. On the other hand, the ferromagnetic elements—gadolinium, iron, cobalt and nickel—form 'peaks' in the 'highlands'. With the exception of the elements of groups 1*a* and 2*a* and aluminium and zirconium, all the paramagnetic elements are confined to the region occupied by the elements belonging to the 'transition series' of the long periods (groups 3*a* to 8$_3$), namely, those elements which in their structure are characterized by the *d*-level electrons.

(2) Properties of Compounds

Numerical data relating to compounds can be mapped over the periodic spiral only in the case of compounds possessing a common component (element or radical). Thus, we can map properties of such compounds as simple oxides, simple carbonates, simple sulphates, and such like, by using the metallic components of these compounds as the index elements of the periodic spiral.

As examples of surfaces showing the distribution of a given property among the compounds, I have chosen the distribution of the heat of formation among simple oxides. The data for the construction of this surface have been obtained from "The Thermochemistry of the Chemical Substances" (1936) by Bichovsky and Rossini. The heat of formation of compounds is usually given per gram-molecule. As the oxides have a great variety of type of molecules, for the purpose of uniformity the heat of formation has been recalculated by me as 'per double bond' of oxygen atom, in calories.

The contour map (Fig. 2) was constructed on the data related to pure compounds. The surface of heat of formation is characterized by a north-west high region, from which stretches a long west–east ridge, occupied by such minerals as corundum (Al_2O_3), rutile (TiO_2), quartz (SiO_2) and cassiterite (SnO_2).

If we take another group of minerals, such as sulphides, for example, we shall see that the heat of formation surface has a shape similar to the heat of formation surface of the oxides, but that the characteristic ridge is half the height of the characteristic ridge of oxides and is also displaced to the 5*a*–3*b* line of the periodic spiral.

Like solubility, melting point or hardness, the heat of formation of compounds may be taken as the index of strength. It is interesting, therefore, especially for a mineralogist or geochemist, to obtain such surfaces for various groups of minerals, so as to be

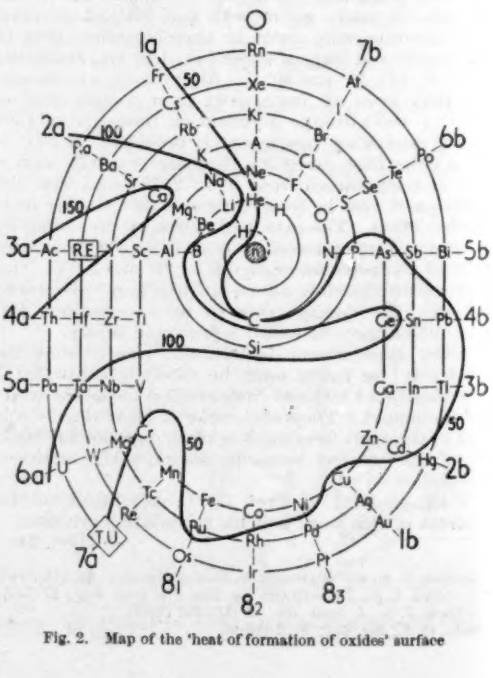

Fig. 2. Map of the 'heat of formation of oxides' surface

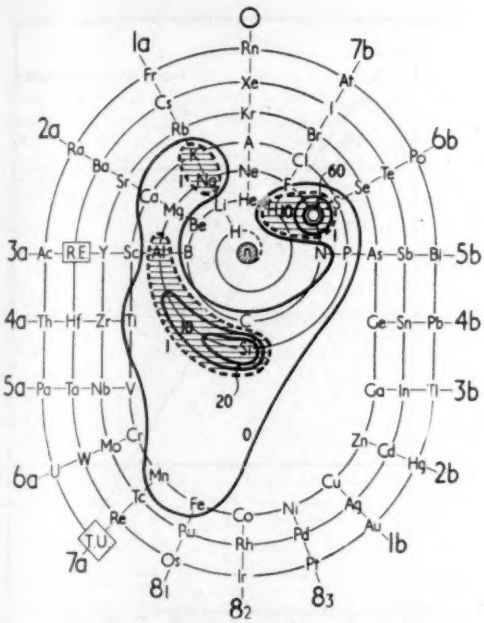

Fig. 3. Map of the 'average composition of granite' surface. Contours: 0—(1)—10—20 . . . . Leading elements (in atomic percentages): O, 63; Si, 24; Al, 4; Na, 2½; H, 2; K, 2

able to evaluate their relative strength as influencing their position in the paragenetic succession. As compared with the heat of formation surfaces, the hardness surfaces are somewhat of analogous shape. Thus the hardness surfaces are characterized by dominant ridges like the heat of formation surfaces. The ridge of the hardness surface of oxides, for example, stretches from corundum (Al_2O_3) via quartz (SiO_2) to cassiterite (SnO_2), while in the case of the hardness surface of sulphides the ridge stretches from laurite (RuS_2) via pyrite (FeS_2) to zinc blende (ZnS).

(3) Composition of Aggregate Bodies

In this case it is not the parameters or numerical values of properties that are mapped, but the percentages (weight, volume or atomic percentages) of elements contained in various bodies, such as organisms, rocks, geospheres, meteorites or even the cosmos. An example of such a surface is that of the average composition of granite.

The 'granite' surface (Fig. 3) is in the form of a broken crater-rim, somewhat distorted by the pulling out of the spiral which forms its co-ordinate net. If we use the evenly coiled Archimedean spiral as the basis of the projection, the broken crater-rim or atoll analogy becomes much clearer. Placed on this crater-rim we have three hills, each corresponding to a pair of the leading elements: oxygen–hydrogen hill, silicon–aluminium hill and sodium–potassium hill with magnesium–calcium extension. Such a grouping is most significant from a geochemical point of view, mainly because it reflects the leptological structure of alkali feldspar, the major constituent of granite. The three hills correspond to the three principal structural units of feldspar, namely, (1) oxygen tetrahedra, with (2) silicon–aluminium cores, and (3) sodium and potassium atoms filling up the 'holes' between the oxygen tetrahedra. The other constituent mineral of granite is mica and quartz. Muscovite mica is made of the same elements as potash feldspar with the addition of the hydroxyl group (OH), and quartz is made of interlinked oxygen tetrahedra alone. Oxygen tetrahedra also form the principal structural units of other silicate minerals. In this way the whole of the lithosphere may be visualized as an aggregate of oxygen tetrahedra, with silicon and aluminium forming their cores and sodium, potassium, calcium, magnesium and iron occupying cavities between them.

In the course of this article reference has been made to a supposed relationship between the periodic table of the elements and their atomic structure. One of the qualities of the spiral periodic table—and one, moreover, which is peculiar to the spiral—is that it is not only a periodic table of the elements but also a symbolic representation—a mirror or a map—of the electronic structure of the atom. This contention may be challenged, but it becomes quite clear if we visualize the three-dimensional atom with its nucleus and its concentric electronic shells as represented in a plane by a central blob for the nucleus and concentric circles for electronic shells. A spiral can easily be formed from these concentric circles by traversing them by a radial line and displacing one cut edge end of each circle one unit distance to the next circle. Place the appropriate number of points along the coils of this spiral, the number corresponding to the saturation number of electrons in successive numbers of electronic shells—2, 8, 8, 18, 18, 32, . . .—and we have the model of the atom in the spiral, which is at the same time a periodic table with the length of each period expressed in terms of the number of elements in it, as determined by the Tomkeieff[1] formula:

$$X = \frac{(2n + 3 + (-1)^n)^2}{8},$$

in which X is the length of the period in terms of the number of elements present in it and n is the principal quantum number of the outer shell of the atoms belonging to this period. The periodic spiral thus mirrors the electronic structure of the atom. This means that whatever data relating to the elements we plot over the periodic spiral by using it as a co-ordinate net, we place directly in a functional relation with the atomic structure the two sets of co-ordinates representing (1) period lines of the elements or the core types of the atomic structure, and (2) the group lines of the elements or the perisphere types of the atomic structure[2].

The maps of the surfaces given and discussed in this article represent a small sample of the cartographical method in which data relating to chemical elements are used for the construction of contours over the periodic spiral used as a co-ordinate net. The surfaces thus constructed do not depend on hypothetical presuppositions but represent true correlation between sets of observed numerical data and the periodic table, and as the periodic table in its turn mirrors the electronic structure of the atom, the correlation is between the observed numerical data and the structure of the atom. The surfaces are true invariants of Nature.

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LETTERS TO THE EDITORS

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Pile Production of Radioisotopes by Threshold Reactions

A GREAT advantage of production of radioisotopes by threshold reactions (n,p) and (n,α), relative to neutron capture (n,γ), is that the radioisotope can be separated chemically from the target material, and hence be obtained in high specific activity, in principle completely carrier-free. The rate of threshold reactions in the pile, however, is much smaller in general than that of capture reactions, not only because of the low cross-sections for neutrons in the MeV. range but also because of the low flux of neutrons of that energy in the pile. As measurement of the small yields of such reactions is often difficult, especially for long-lived radioisotopes, it is very useful to be able to predict approximate yields in advance. An example is furnished by the reaction $^{54}Fe(n,p)^{54}Mn$, recently discussed by Stafford and Stein[1]; in this case some experiments had indicated production of the 324-day manganese-54 by pile neutrons, whereas others showed none. The most recent experiments[1], however, utilizing samples enriched in iron-54, definitely established the reaction with a cross-section for fast neutrons of 11 millibarns (10^{-27} cm.^{2}). It is the purpose of the present communication to point out that the approximate yields for threshold reactions in the pile can be predicted, and to illustrate the method for $^{54}Fe(n,p)^{54}Mn$ as an example.

A systematic survey of threshold reaction cross-sections for fission neutrons was carried out by Hughes, Spatz and Goldstein[2] in 1946. Whereas the original purpose of the measurements was to investigate the shape of the fission neutron spectrum at high energies, the present well-known spectrum[3] allows the results to be used to systematize the reaction yields. It is found[4] that the threshold reaction cross-section for fission neutrons is proportional to the integral of the fission spectrum above an 'effective energy', E_{eff}, which is a few MeV. higher than the threshold energy for the reaction, E_T. The quantity $E_{eff} - E_T$, which rises rapidly with atomic number, is simply related to the penetrability of the outgoing particle and the fission spectrum shape. Results for (n,p) reactions only are given in Fig. 1, where the cross-sections, multiplied by $10/A^{2/3}$ to correct for variation in nuclear size, are plotted against E_{eff} and compared with the integral of the fission spectrum (solid line). The average deviation of the experimental points from the curve is about a factor of two, although the cross-sections themselves cover a range of 3,000-fold. The results of Fig. 1 indicate that the cross-section for the (n,p) reaction for a neutron energy at which the penetrability becomes unity is approximately proportional to πR^2 (with R the nuclear radius), actually being about $0{\cdot}1\ \pi R^2$, as compared to $0{\cdot}2\ \pi R^2$ for (n,α) reactions[4].

For the $^{54}Fe(n,p)$ reaction, E_T is given by the mass difference manganese-54 – iron-54[5] (0·71 MeV.) minus the n–p mass difference (0·78 MeV.), or − 0·07 MeV. The quantity E_{eff} for this reaction is then found to be 4·2 MeV., and $\sigma 10/A^{2/3}$ is obtained from Fig. 1 as 7 mb. The cross-section itself is 9·5 mb. ($A^{2/3} = 13{\cdot}5$), in surprisingly good agreement with the 11 mb.

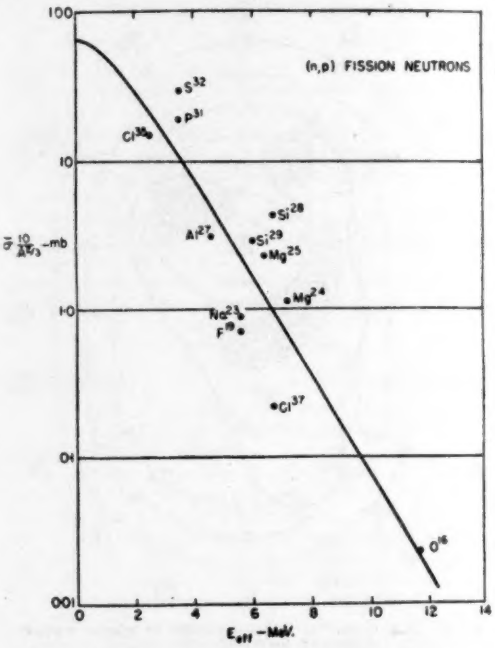

Fig. 1. Measured cross-sections of (n,p) reactions for fission neutrons as a function of effective energy compared with the integral of the fission neutron energy spectrum

measured by Stafford and Stein[1]. Although Fig. 1 refers to cross-sections for unmoderated fission neutrons, the cross-sections for pile neutrons as well are principally a result of unmoderated fission neutrons, for which the flux near a uranium fuel rod is approximately equal to the thermal flux[6]. It is interesting that the curve of Fig. 1 works well for the iron-54 reaction even though the experimental points used to normalize it were all for lighter elements.

The practical value of Fig. 1 and the corresponding curve for (n,α) reactions arises from the fact that approximate yield predictions can be made and thus complex and lengthy measurements avoided. The cross-sections will, of course, decrease rapidly for higher values of Z; for example, for E_T near zero, the cross-sections for (n,α) and (n,p) reactions decrease from 16 and 30 mb. respectively at $Z = 10$, to 0·01 and 1·5 mb. at $Z = 40$. Large variations in E_T occur for light elements, but these become smaller, and affect the cross-sections less, as Z increases.

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Clarendon Laboratory,
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Dec. 16.

* On leave as a Fulbright Professor from Brookhaven National Laboratory, Upton, N.Y.

[1] Stafford, G. H., and Stein, L. H., *Nature*, **172**, 1103 (1953).
[2] Hughes, Spatz and Goldstein (unpublished, see ref. 4).
[3] Bonner, Ferrel and Rinehart, *Phys. Rev.*, **87**, 1032 (1952). Hill, D. L., *Phys. Rev.*, **87**, 1034 (1952). Watt, B. E., *Phys. Rev.*, **87**, 1037 (1952).
[4] The measurements, as well as the details of their interpretation, are described by the author in "Pile Neutron Research", 93 (Addison-Wesley, 1953).
[5] Collins, Nier and Johnson, *Phys. Rev.*, **86**, 408 (1953).
[6] Ref. 4, pp. 60, 106.

Tidal Forces and the Formation of Hurricanes

MAY I raise the following question: "Do tidal forces affect the formation of hurricanes?" If one examines the changing direction of the tidal force due to the sun and a moon near new (or full) on an August day, say, as this force acts on a small element of air located at a point south of the sub-solar latitude and north of the equator, one finds the tidal force would tend to make the atmospheric element move in a counter-clockwise direction as viewed from above. Furthermore, as the sun moves southward in August and early September, the latitudes where the highest atmospheric tides would be expected (here considered semi-diurnal), would fall alternately north and south of the equator, the successive points on either side approaching the equator. Might there not be one time at which the separation of these two latitudes would correspond to a natural frequency of oscillation of the atmosphere? If these arguments have any validity, the hurricanes in the North Atlantic should show an increase in number shortly before September 23 and a decrease shortly after that date.

The first date given for each tropical storm in the years 1900–49 inclusive was taken from Tannehill's "Hurricanes" (eighth revised edition, Princeton University Press, 1952) and the frequencies noted for a number of intervals in the hurricane season. The results are shown in Table 1.

Table 1

Interval	Number	Number per week
August 24–31	32	28
September 1–7	27	27
September 8–14	40	40
September 15–22	32	28
September 23–30	20	17·5
October 1–7	27	27
October 8–14	26	26

To determine whether the change from 40 for September 8–14 to 17·5 (per week) for September 23–30 was statistically significant, the fifty-year period was broken into five ten-year blocks and averages and variances determined. It was found that the change corresponded to a 2 per cent level of significance, that is, that this might happen by chance once in fifty times.

Also, if tidal forces play an important part in the formation of hurricanes, they should leave their mark on year-by-year statistics. Here I elected to break up the eighteen-year interval into four periods of four, five, four and five years. Then the number of hurricanes in each four-year period was increased by 25 per cent so that the comparison might be made on a uniform five-year basis. The results, again based on Tannehill, are shown in Table 2.

Table 2

Interval	Number	Number per 5 years
1902–1905	24	30
1906–1910	35	35
1911–1914	16	20
1915–1919	28	28
1920–1923	19	23·8
1924–1928	34	34
1929–1932	22	27·5
1933–1937	61	61
1938–1941	27	33·8
1942–1946	44	44

The average (on a five-year basis) for the four-year intervals was 27·2 ($\sigma = 4·8$). For the five-year intervals, the average was 40·4 ($\sigma = 11·5$).

I am aware that the tidal forces are not large; but I would suggest that in meteorology the result is not always proportional to the force that triggers the action. I suggest that an investigation of atmospheric tides and their effects on the formation of hurricanes would be worth while.

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Nov. 2.

Irradiation of Transistors

THE effect of stored holes in transistors has been reported by Meacham and Michaels[1], and the importance of the effect in the design of switching circuits was stressed by speakers in the discussion following a paper by Williams and Chaplin[2]. Briefly, good circuit design often necessitates operating a transistor in the condition where the collector current is limited by an external resistance; in this condition the time of fall of collector current upon cessation of emitter current is found to be much slower than when the collector current is limited only by the current gain of the transistor. It is the time of fall of collector current which determines the maximum switching speed of a transistor.

During some irradiation experiments on commercial point-type transistors in the Harwell pile, we have found that if a transistor is given a radiation dose of about 10^{14} neutrons/sq. cm., the time of fall of collector current from the value limited as described above is decreased, with little or no deterioration of the other parameters of the transistor. Curves of collector current against time after the sudden cessation of an emitter current of 3 m.amp. are shown in Fig. 1 for the same transistor before irradiation and 2 hr. afterwards. The transistor used had a current gain of 2·2, so that at least 6·6 m.amp. of collector current was available; the collector current was limited to about 5·4 m.amp. by an external resistance.

Measurements have been repeated at intervals over a period of four weeks from the time of irradiation and have shown little change. Measurements after

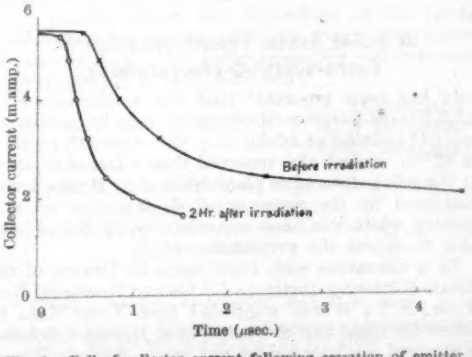

Fig. 1. Fall of collector current following cessation of emitter current

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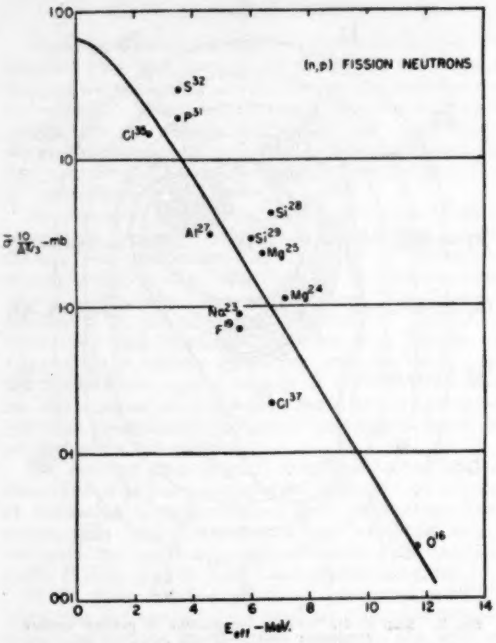

Fig. 1. Measured cross-sections of (n,p) reactions for fission neutrons as a function of effective energy compared with the integral of the fission neutron energy spectrum

measured by Stafford and Stein[1]. Although Fig. 1 refers to cross-sections for unmoderated fission neutrons, the cross-sections for pile neutrons as well are principally a result of unmoderated fission neutrons, for which the flux near a uranium fuel rod is approximately equal to the thermal flux[6]. It is interesting that the curve of Fig. 1 works well for the iron-54 reaction even though the experimental points used to normalize it were all for lighter elements.

The practical value of Fig. 1 and the corresponding curve for (n,α) reactions arises from the fact that approximate yield predictions can be made and thus complex and lengthy measurements avoided. The cross-sections will, of course, decrease rapidly for higher values of Z; for example, for E_T near zero, the cross-sections for (n,α) and (n,p) reactions decrease from 16 and 30 mb. respectively at $Z = 10$, to 0·01 and 1·5 mb. at $Z = 40$. Large variations in E_T occur for light elements, but these become smaller, and affect the cross-sections less, as Z increases.

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Tidal Forces and the Formation of Hurricanes

MAY I raise the following question: "Do tidal forces affect the formation of hurricanes?" If one examines the changing direction of the tidal force due to the sun and a moon near new (or full) on an August day, say, as this force acts on a small element of air located at a point south of the sub-solar latitude and north of the equator, one finds the tidal force would tend to make the atmospheric element move in a counter-clockwise direction as viewed from above. Furthermore, as the sun moves southward in August and early September, the latitudes where the highest atmospheric tides would be expected (here considered semi-diurnal), would fall alternately north and south of the equator, the successive points on either side approaching the equator. Might there not be one time at which the separation of these two latitudes would correspond to a natural frequency of oscillation of the atmosphere? If these arguments have any validity, the hurricanes in the North Atlantic should show an increase in number shortly before September 23 and a decrease shortly after that date.

The first date given for each tropical storm in the years 1900–49 inclusive was taken from Tannehill's "Hurricanes" (eighth revised edition, Princeton University Press, 1952) and the frequencies noted for a number of intervals in the hurricane season. The results are shown in Table 1.

Table 1

Interval	Number	Number per week
August 24–31	32	28
September 1–7	27	27
September 8–14	40	40
September 15–22	32	28
September 23–30	20	17·5
October 1–7	27	27
October 8–14	26	26

To determine whether the change from 40 for September 8–14 to 17·5 (per week) for September 23–30 was statistically significant, the fifty-year period was broken into five ten-year blocks and averages and variances determined. It was found that the change corresponded to a 2 per cent level of significance, that is, that this might happen by chance once in fifty times.

Also, if tidal forces play an important part in the formation of hurricanes, they should leave their mark on year-by-year statistics. Here I elected to break up the eighteen-year interval into four periods of four, five, four and five years. Then the number of hurricanes in each four-year period was increased by 25 per cent so that the comparison might be made on a uniform five-year basis. The results, again based on Tannehill, are shown in Table 2.

Table 2

Interval	Number	Number per 5 years
1902–1905	24	30
1906–1910	35	35
1911–1914	16	20
1915–1919	28	28
1920–1923	19	23·8
1924–1928	34	34
1929–1932	22	27·5
1933–1937	61	61
1938–1941	27	33·8
1942–1946	44	44

The average (on a five-year basis) for the four-year intervals was 27·2 ($\sigma = 4·8$). For the five-year intervals, the average was 40·4 ($\sigma = 11·5$).

I am aware that the tidal forces are not large; but I would suggest that in meteorology the result is not always proportional to the force that triggers the action. I suggest that an investigation of atmospheric tides and their effects on the formation of hurricanes would be worth while.

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Irradiation of Transistors

THE effect of stored holes in transistors has been reported by Meacham and Michaels[1], and the importance of the effect in the design of switching circuits was stressed by speakers in the discussion following a paper by Williams and Chaplin[2]. Briefly, good circuit design often necessitates operating a transistor in the condition where the collector current is limited by an external resistance; in this condition the time of fall of collector current upon cessation of emitter current is found to be much slower than when the collector current is limited only by the current gain of the transistor. It is the time of fall of collector current which determines the maximum switching speed of a transistor.

During some irradiation experiments on commercial point-type transistors in the Harwell pile, we have found that if a transistor is given a radiation dose of about 10^{14} neutrons/sq. cm., the time of fall of collector current from the value limited as described above is decreased, with little or no deterioration of the other parameters of the transistor. Curves of collector current against time after the sudden cessation of an emitter current of 3 m.amp. are shown in Fig. 1 for the same transistor before irradiation and 2 hr. afterwards. The transistor used had a current gain of 2·2, so that at least 6·6 m.amp. of collector current was available; the collector current was limited to about 5·4 m.amp. by an external resistance.

Measurements have been repeated at intervals over a period of four weeks from the time of irradiation and have shown little change. Measurements after

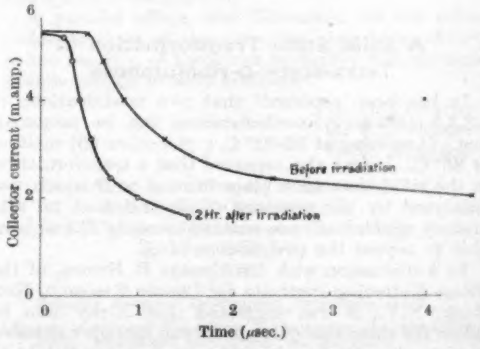

Fig. 1. Fall of collector current following cessation of emitter current

150 cycles of temperature from ambient to 70° C. have also indicated that the change in time of fall of collector current due to irradiation should be permanent.

A sample of mono-crystalline germanium has also been irradiated with a dose of 10^{14} neutrons/sq. cm. A rise in resistivity from 2·03 ohm cm. to 2·24 ohm cm. and a decrease in hole life-time, measured by a modified light-spot system[3], from 1·6 μsec. to 0·6 μsec. were observed, with little change in hole mobility. In addition, two samples of 6 ohm cm. material have been measured by the Post Office Research Station, Dollis Hill. Decreases in hole life-time from 50 μsec. to 6 μsec. and from 6 μsec. to 1 μsec. have been reported.

The most abundant expected transmutations[4] are as follows:

		No of atoms produced
$^{70}Ge\ (n,\gamma)\ ^{71}Ge \xrightarrow{11{\cdot}4\ days\ \beta^+} {}^{71}Ga$		$3{\cdot}1 \times 10^{13}$/c.c.
$^{74}Ge\ (n,\gamma)\ ^{75}Ge \xrightarrow{82\ min.\ \beta^-} {}^{75}As$		1×10^{13}/c.c.
$^{76}Ge\ (n,\gamma)\ ^{77}Ge \xrightarrow{12\ hr.\ \beta^-} {}^{77}As \xrightarrow{40\ hr.\ \beta^-} {}^{77}Se$		1×10^{11}/c.c.

These yields of impurities are low compared with those normally present, and no changes with time since irradiation consistent with these half-times have been observed.

We therefore believe that the decreased time of fall of collector current is caused by the production of recombination centres, such as lattice defects, in the bulk material.

These and similar experiments are being continued. We should like to thank the Chief Superintendent, Services Electronics Research Laboratory, for measurement facilities on germanium placed at our disposal.

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A Solid State Transformation in Tetra-acetyl-D-ribofuranose

It has been reported[1] that two modifications of 1,2,3,5-tetra-acetyl-D-ribofuranose can be prepared, one (*A*) melting at 56–58° C.; the other (*B*) melting at 85° C. It was also reported that a transformation in the solid state took place from *A* to *B* which was catalysed by the presence of *B*, and that no laboratory which was once contaminated by *B* had been able to repeat the preparation of *A*.

In a discussion with Dr. George B. Brown, of the Sloan–Kettering Institute for Cancer Research, New York, N.Y., it was suggested that X-ray data be taken for these two materials, even though a detailed structural analysis might not prove immediately to be feasible.

Several months later, a single crystal suitable for X-ray work was obtained from a sample of the *A*-material prepared and sent to us by Dr. Irving Goodman, of the Wellcome Research Laboratories, Tuckahoe, N.Y. The X-ray study was carried out by Weissenberg and Buerger precession techniques. There are two molecules in a monoclinic cell of the space group $P2_1$ the dimensions of which are:

$a = 12{\cdot}49$ A., $b = 5{\cdot}58$ A., $c = 11{\cdot}12$ A., $\beta = 97° 45'$.

Weissenberg multiple-film photographs for the layers *h*0*l*, *h*1*l*, *h*2*l* were taken with copper radiation. Precession photographs using copper and molybdenum were taken of the *hk*0, *hk*1, 0*kl* and 1*kl* layers.

The single crystal of the *A*-material mounted for X-ray examination remained stable for seven weeks. At the end of this period crystals of the *B*-modification were obtained from Dr. Brown and were also mounted for X-ray examination. The *A*-crystal remained stable in the same room with the *B*-crystals for about three days. Some of the *B*-material was powdered and sprinkled over the *A*-crystal at the start of a Laue photograph exposure. The resulting film indicated that the *A*-crystal had transformed completely to the *B*-material in 5–15 min. The transformed material, a fine powder of the *B*-substance, formed an opaque block in the external shape of the original *A*-crystal. It had been hoped that the transformed powder would show some preferred orientation with respect to the original *A*-structure, but this was not apparent.

Weissenberg and precession photographs of the stable *B*-material identified the space group as $P2_12_12_1$ with four molecules in a cell of dimensions:

$a = 7{\cdot}50$ A., $b = 13{\cdot}66$ A., $c = 15{\cdot}33$ A.

No systematic collection of intensity data for the *B*-material has been undertaken.

It is interesting to note that the molecular volume increased by about two per cent during the transformation (*A*: 383·9 A.[3]; *B*: 392·5 A.[3]).

At the present time, we do not contemplate detailed analysis of the data we have obtained. We shall be glad to furnish further information on our results to those who are interested.

It is a pleasure to thank Dr. Brown for his suggestion and discussion of this investigation and for the material which he supplied us. We are also very grateful to Dr. Goodman for the sample of the rare *A*-material.

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Static Electrification of Petrols

It is well known that petrols flowing down a tube acquire a quite considerable electrostatic charge, and it is perhaps less well known that the addition of a reasonable quantity of alcohol reduces this charge to insignificant proportions[1]. Some recent experiments on the effect of small quantities of alcohol reveal, however, very puzzling results. The pure petrol always acquires a positive charge and the addition of slightly more than 1 per cent of alcohol reduces the charge to zero; but what is remarkable is that the addition of a little more alcohol produces a

negative charge until about 8 per cent, after which the charge is negligible.

This general result is true (though the magnitude of the charges vary) for all the different brands of petrol tested and also for toluene. It is true whether the flow is steady or turbulent, and is unaffected by altering the materials of the tube. In fact, the same thing occurred when the mixture ran through muslin or a filter paper, in both of which cases the charges were far higher than when the mixture was running down a metal tube.

As an example, 20 c.c. of 82 octane aviation spirit run down a Dural tube 40 cm. long and 5 mm. diameter acquired when pure a charge of + 1·5 e.s. units ; 2 per cent of alcohol reduced this to zero, and from 2 to 8 per cent the charge was negative, rising to a maximum of − 22 e.s. units for 4 per cent and thereafter decreasing. Thus the charge is not only reversed but also becomes much larger than for the unadulterated petrol.

The only part of the phenomenon which is readily understandable is the disappearance of the charge for the higher concentrations. The petrol itself has an enormous electrical resistance, but the addition of alcohol much reduces it and the charges acquired by contact with the tube then leak back to it before they can be carried away by the emerging liquid. The specific resistance of the aviation spirit was of the order of 5×10^{13} ohms per cm. cube. The addition of each successive 2 per cent of alcohol reduced the resistance by a factor very close to 10, so that the 8 per cent solution had ten thousand times the conductivity of the spirit.

It would be wise, however, to hesitate before theorizing as to the cause of the reversal of sign of the charge, as the following experiment shows that things are more complex than might appear at first sight.

If a mixture is chosen giving the negative charge, and the same specimen is poured repeatedly down the same tube, the negative charge decreases each time, finally becoming positive and ending up for some concentrations at a value rather higher than the unadulterated petrol produces. This surprising change in the charge is not the result of the mixture altering in any way by evaporation or otherwise, for the resistance remains unaltered.

It would appear, therefore, that the negative charge is not due to the alcohol–petrol mixture, but to minute quantities of some third substance which is removed by the ions transferred in each run down the tube. Whether this third substance is the small amount of water always found in alcohol is uncertain.

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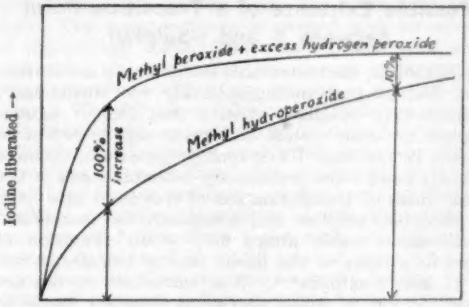
Effect of Hydrogen Peroxide on the Analysis of Organic Peroxides

In many combustion products, hydrogen peroxide forms a large part of the peroxidic products isolated[1]. It is therefore worth recording some observations on the interference caused by hydrogen peroxide in the analysis of such mixtures as hydrogen peroxide and methyl hydroperoxide.

It has long been known[2] that alkyl hydroperoxides, unlike hydrogen peroxide, do not liberate the stoichiometric quantity of iodine from acidified potassium iodide. It has now been found that the extent to which they react depends, not only on the time, and on the type and amount of catalyst, but also on the concentration of any hydrogen peroxide which is present.



The estimations were carried out in an atmosphere of oxygen-free nitrogen in stoppered flasks in the absence of light. The test solution, containing hydrogen or methyl peroxide, or both, was added to 25 ml. of 2 *N* hydrochloric acid together with 1 c.c. of 50 per cent potassium iodide. Any catalyst was added at this stage. Nitrogen was again passed, and the flask stoppered. A blank run, free of peroxide, was also carried out. The catalyst, either ammonium molybdate or ferrous sulphate, was added in the form of three drops of a 2 per cent solution. After a given time, the iodine was titrated against 0·01 *N* sodium thiosulphate. The following results are typical of many others which were obtained.

In the presence of 6·42 ml. of 0·01 *N* hydrogen peroxide, the iodine liberated by a constant amount (10·4 ml. of 0·01 *N*) of methyl hydroperoxide was increased by 16 per cent after 1½ hr. by the addition of ferrous sulphate, while ammonium molybdate had practically no effect during this time. However, it was found that, if the concentration of hydrogen peroxide was increased thirty times, the iodine liberation of the methyl hydroperoxide was increased by 57 per cent after 3 hr., and by 28 per cent after 15 hr. It is clear that the indicated concentration of organic peroxide depends both on the ratio $H_2O_2/ROOH$ and on the time, as is shown schematically in Fig. 1. Evidently, the interpretation of iodometric estimations of peroxide mixtures must be made with great caution.

A parallel effect, also dependent on the relative concentrations of the peroxides, has been observed in the reaction of the lower peroxides with potassium permanganate in acid solutions[3].

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[1] Everett and Minkoff, Third Symp. on Combustion, etc., 390 (Baltimore, 1949). Minkoff and Salooja, *Fuel*, **32**, 516 (1953).
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Possible Existence of a Transition Point between β- and γ-Sulphur

γ-Sulphur, the metastable monoclinic modification first described crystallographically by Muthmann[1], is frequently obtained when a thin film of molten sulphur between a slide and cover slip is caused to solidify by chilling. Using such preparations, we have recently made some preliminary determinations of the linear rates of transformation of this form into both α- (rhombic) sulphur and β-sulphur, the monoclinic modification stable above 96°, as an extension of previous studies of the linear rate of transformation of β- into α-sulphur[2-4]. The smoothed results are shown in Fig. 1, which also gives those for the β- to α-transformation. The three curves intersect at *A*, *B* and *C*, and although the temperature co-ordinates given for these points, namely, 12°, 55° and 75° respectively, can only be regarded as approximate at present, their existence is not in any doubt, since they have been confirmed by a number of observations of the relative rates of the transformations on slides on which all three forms were present.

The existence of a point *A* at which the rates of transformation of β to α and of γ to α are equal raises the interesting question as to whether there is a transition point between β- and γ-sulphur at or near this temperature. This possibility is suggested by the following considerations. In certain theories already put forward to account for the linear rate of polymorphic transformations[5], the rate may be expressed as a function of the free energy change, the temperature, and the vapour pressure of one of the two modifications. Thus the expression proposed by one of us (N. H. H., *ibid.*, p. 150) may in its simplest form be rewritten as:

$$v_{II,I} = \text{const. } p_I [\exp(-\Delta G/RT) - 1], \quad (1)$$

where $v_{II,I}$ is the rate, p_I is the vapour pressure of the stable form, and the other symbols have their usual significance. Again, Dunning's equation (*ibid.*, p. 157) may be put in the form:

$$v_{II,I} = \text{const. } p_I \cdot \exp(-\Delta G/RT) \cdot \exp[\text{const.}/(\Delta G.RT]. \quad (2)$$

These alternative forms are obtained by using the relationships:

$$p_I = \text{const. } \exp(-L_I/RT);$$
$$-\Delta G = q[(T_0 - T)/T_0] = RT \ln(p_{II}/p_I),$$

where L_I is the latent heat of sublimation of the stable form, q is the heat of transformation, T_0 the transition temperature, and p_{II} is the vapour pressure of the unstable form. The constants in (1) and (2) depend only on the properties of the stable form.

On this basis, we have for the β to α and γ to α transformations:

$$v_{\beta\alpha} = F(\Delta G_{\beta\alpha}, T, p_\alpha),$$
or $$\Delta G_{\beta\alpha} = H(v_{\beta\alpha}, T, p_\alpha), \quad (3)$$

and also $$\Delta G_{\gamma\alpha} = H(v_{\gamma\alpha}, T, p_\alpha), \quad (4)$$

where F and H signify 'function of'.

The two functions (3) and (4) are of the same form and contain the same constants since the stable form (α) is the same in both cases.

For the γ- to β-transformation, we may write:

$$\Delta G_{\gamma\beta} = J(v_{\gamma\beta}, T, p_\beta),$$

where J signifies a function which will contain different constants from those in (3) and (4), since the more stable phase is now β.

Now $$\Delta G_{\gamma\beta} = \Delta G_{\gamma\alpha} - \Delta G_{\beta\alpha};$$

so that if $v_{\gamma\alpha} = v_{\beta\alpha}$, $\Delta G_{\gamma\alpha} = \Delta G_{\beta\alpha}$ and $\Delta G_{\gamma\beta} = 0$, that is, a transition point exists at this temperature between the γ- and β-forms.

This treatment, however, takes no account of adventitious factors such as the mosaic block size of the unstable form or the difference in densities of the two forms, which may affect the rates of transformation of β to α and γ to α to different extents (see, for example, reference 3, p. 1112, for discussion of the possible effect of mosaic block size), so that equality of the rates at a certain temperature does not necessarily mean that the free energies of the β- and γ-forms are the same at this temperature. It does, however, suggest that they may be equal at a temperature near this.

The simplest experimental test of the existence of a γβ-transition point would appear to be to see whether a reversal in the direction of movement of the γβ-interface occurs at low temperatures; but this test has failed because at temperatures below 40° no movement whatsoever of this interface can be detected (at least down to −15°, the limit of our observations) even under a high-power microscope over a period of some weeks. The very high temperature coefficient of this transformation at temperatures above 40°, which corresponds to an apparent activation energy of about 150,000 cal. per mole (curve *BC* below *B*), however, is just what would be expected if there were a transition point not too far below this temperature. General theoretical considerations based on the fact that above a transition point both molecular motion and 'driving force' (that is, free energy change) increase with rise of temperature, and also experimental observations, for example, on the α- to β-transformation in sulphur above 96°, support this.

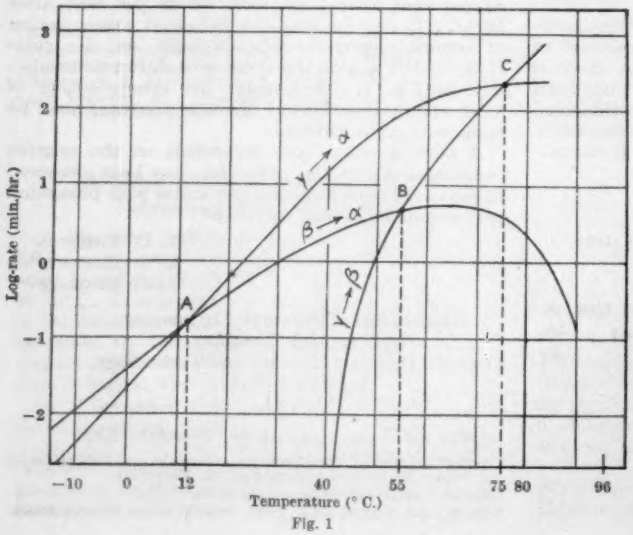

Fig. 1

The phase transformations in sulphur are markedly accelerated when it is contaminated with carbon disulphide, and in films prepared from such material we have found that the temperature of the αβ-transition point is not altered within the limits of accuracy (about 2°) of the hot stage used for our observations. This suggests that the carbon disulphide adds another phase as well as another component to the system, and this phase appears to be a liquid layer at the interface, since under the microscope bubbles can be seen moving about in this region as the reaction proceeds. If a γβ-interface is established in such contaminated sulphur, observable movement at low temperatures now occurs; but at all temperatures down to − 18° (the lowest attainable for microscopic observations with our present arrangements) the direction of the transformation is still γ to β. Thus the transition point, if it exists, is probably below this temperature.

Point *C* (Fig. 1) represents a somewhat similar case to that just discussed, for here the rates of transformation of γ to α and γ to β are equal, and the well-established transition point between the α- and β-forms exists at the not far distant temperature of 96°. The difference from the previous case is that the reactant phase (γ) is the same in the two transformations, whereas at point *A* it is the resultant phase (α) which is the same.

This work will be described and discussed in more detail in a further publication. It is also intended to attempt determinations of the vapour pressures of the β- and γ-forms down to low temperatures. This should provide conclusive evidence of the existence or otherwise of a transition point between these forms.

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A Rapid Gasometric Method of Analysis for 'Reducing' Sugars and Other Carbonyl Compounds

Analysis for reducing sugars generally involves oxidation under highly disruptive conditions with an alkaline reagent. As a consequence of the oxidative fragmentation of the sugars, the stoichiometry of the reaction is not simple, and it is necessary to employ closely controlled concentration and temperature conditions[1]. The interpretation of the results requires the use of extensive empirical tables. Since the reducing equivalence of the various mono- and di-saccharides is not the same, an additional dimension of uncertainty is introduced into the procedure for the analysis of mixtures of reducing sugars.

Employing aqueous solutions of sodium borohydride for the reduction of 'reducing' sugars to the corresponding polyols, we have been able to carry out the rapid determination of reducing sugars at acidities of *p*H 7 and higher. Sodium borohydride solution is standardized by measuring the volume of hydrogen gas evolved when the solution is made acid. The sugar solution is treated with an aliquot of the sodium borohydride reagent, and after completion of the reduction, the excess of reagent is determined by acidification, etc., as in the standardization. The difference in volume of hydrogen evolved is equivalent to the amount of 'reducing' sugar. By collecting the hydrogen over water in a very simple apparatus, we have found that one mole of hydrogen is utilized for the reduction of one mole of glucose, fructose, galactose, lactose or glucosamine with an accuracy of better than 1 per cent. Complete reduction is achieved in 20–30 min. at room temperature, or in less than one minute at the boiling point. Although aqueous sodium borohydride solutions are stable at room temperature, aliquots are most conveniently pipetted at 0° C.

Since this analytical method has many obvious applications in organic, biochemical and clinical analyses, it was considered advisable to make a preliminary report. Detailed results relating to sugar analysis, and analysis for carbonyl compounds and derivatives in general will be published later.

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The Girard Reaction

Girard and Sandulesco[1] developed a method now known as the 'Girard reaction' for the isolation of small amounts of ketosteroids such as the sex hormones from natural products. Aldehydes and ketones in the mixture are converted into water-soluble hydrazone derivatives by treatment with the 'Girard P' or 'T' reagent, and the non-carbonyl compounds are removed by extraction with a non-polar solvent like ether. The ketone complexes are rapidly decomposed with mineral acid; but the aldehyde derivatives are claimed to be stable except in the presence of a large excess of acid and formaldehyde.

Recently, in an investigation of the compounds responsible for the so-called 'cardboard' flavour in skim milk, acetaldehyde was observed in 'ketonic fractions' isolated by these methods.

A study of the literature showed that Girard aldehyde complexes are not as stable as generally believed, for Lederer and Nachmias[2] were able to decompose some of them with hydrochloric acid after 12–14 hr. at room temperature giving 80–90 per cent yields of heptaldehyde, citral, *m*- and *p*-hydroxybenzaldehyde, 3,4-dihydroxybenzaldehyde and piperonal.

We were interested in saturated and unsaturated aliphatic aldehydes and ketones, and studied the stability of the 'Girard P' complexes of acetaldehyde, crotonaldehyde, propionaldehyde, butyraldehyde, *iso*-valeraldehyde and *n*-heptaldehyde and acetone, methyl ethyl ketone, mesityl oxide and methyl *n*-amyl ketone. In all cases the decomposition of the Girard complex with *N*/2 sulphuric acid was found to be almost instantaneous.

It seems that the Girard reaction, while it often fails to separate aldehydes and ketones, may be suitable for the separation of carbonyl from non-carbonyl

compounds. In many cases the liberated aldehydes and ketones can be extracted as soon as the mineral acid is added.

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Melbourne, Australia. Sept. 22.

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Anthocyanins in Bananas

The inflorescence of the banana bears female flowers at the base and male flowers apically. At each node is a cluster of flowers subtended by a brightly coloured bract, and it is upon the anthocyanins of these bracts that most of the results summarized below are based. The pigments were extracted in 1 per cent hydrochloric acid and examined in the test-tube and by paper chromatography. A picrate which was isolated from one species yielded glucose only on hydrolysis. Definition of the glycosidal types awaits determination of the sugar residues in other purified samples. After hydrolysis, the anthocyanidins were determined by means of chromatography in the Forestal solvent[1] and in butanol–2*N* hydrochloric acid[2] used separately, or jointly for a two-way separation.

The anthocyanidins. Six anthocyanidins were found, namely: pelargonidin, cyanidin, peonidin, delphinidin, petunidin and malvidin. Bract colours vary correspondingly from scarlet to deep purple or violet. Specific occurrences were as follows.

(1) Pelargonidin–cyanidin mixture: *Musa coccinea* (one clone examined).

(2) Cyanidin–delphinidin mixtures: *M. laterita* (one clone), *M. balbisiana* (ten clones), *M. velutina* (one clone).

(3) Partly methylated cyanidin–delphinidin mixtures (that is, mixtures of cyanidin, peonidin, delphinidin, petunidin and malvidin in various proportions): *M. acuminata* (twelve clones).

(4) Methylated cyanidin and delphinidin (peonidin and malvidin in various proportions): *M. ornata* (one clone), *M. violascens* (one clone) and an undescribed species from Assam (two clones).

Several anthoxanthins are present and their occurrences also show signs of being related to taxonomy.

Special interest centres on *M. acuminata* as the most variable species and the most important from the point of view of origins of edible bananas[3]. Two-way chromatograms of the anthocyanidins of eleven clones were made, and each paper was scored by two independent observers for relative intensity of the various pigments; the whole series was repeated and the results for one pigment (malvidin—more or less arbitrarily selected) were analysed, thus:

Item	*D.f.*	*M.S.*	*V.R.*	*P*
Clones	10	79·31	69·5	0·1 per cent
Replicates	1	6·57	5·76	5 per cent
Observers	1	5·12	4·49	—
Clones × replicates	10	3·77	3·30	5 per cent
Clones × observers	10	0·71	—	—
Replicates × observers	1	1·84	—	—
Error	10	1·14	—	—

There are real differences between clones, though the clones × replicates interaction shows that the proportion of malvidin varied slightly as between samplings. There is excellent agreement between the scorings of the two observers. Thus, it may be suggested that the anthocyanidins could be estimated by measurement of optical density of the spots.

The clones of *M. acuminata* which were used came from various parts of the Far East between Java and Burma; between these extremes there is a cline of bract colour from red in the south to dull purple in the north. This cline is an expression of changing proportions of the anthocyanidins (Fig. 1); delphinidin increases to northward and, simultaneously, the degree of methylation also increases. Probably delphinidin derivatives have increased under natural selection for blueness and methylation has followed under natural selection for stability.

Edible bananas have, broadly speaking, the pigments expected on taxonomic grounds. Thus, cultivated varieties of *M. acuminata* have (with one interesting exception) partly methylated mixtures of cyanidin and delphinidin, and varieties allied to, but not necessarily wholly derived from, *M. balbisiana* have no methylation.

Ontogeny of pigmentation. The male bud of the banana is composed of a short flower-bearing axis covered with tightly imbricate bracts. The outside bracts are the oldest and are fully coloured; successively younger bracts are smaller and paler and at about bract number 9 colour disappears. Now this bract seriation represents an ontogenetic sequence, and it is therefore possible to follow the development of pigmentation from inception to maturity. The photograph (Fig. 2) shows the results of one experiment; the white bracts on the right contained leucocyanidin and leucodelphinidin; as visible colour appeared so methylated pigments also appeared, and at maturity the anthocyanins were glycosides of peonidin, malvidin, cyanidin and delphinidin. It is not possible here to determine with certainty the relative contributions of the products of hydrolysis of unmethylated leuco-substances and aglycones of the corresponding visible pigments. However, judging by the comparative intensities of the various anthocyanin and anthocyanidin spots, the leuco-substances (as revealed by this method of extraction) had almost disappeared from the mature

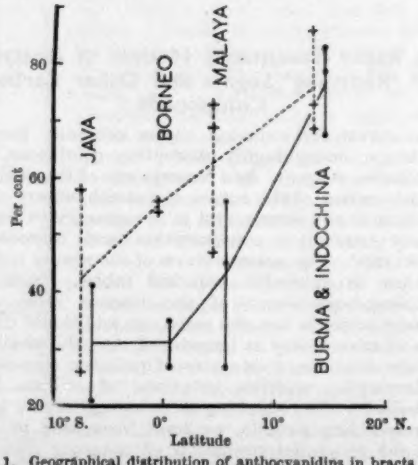

Fig. 1. Geographical distribution of anthocyanidins in bracts of *Musa acuminata*. Solid lines, proportion of delphinidin derivatives; dotted lines, proportion of pigments methylated

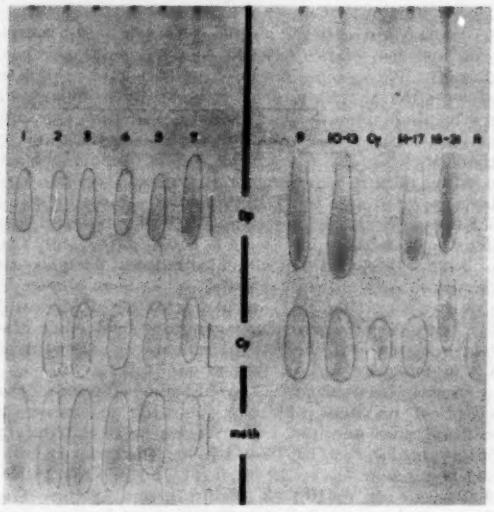

Fig. 2. Ontogeny of anthocyanidins in a male bud of *Musa acuminata* clone Langet *A*. Mature bract (No. 1) on the left, Nos. 2–7 successively younger and more lightly pigmented; on the right, immature colourless bracts containing leucocyanidin (cyanidin marker, cy) and leucodelphinidin. 'Meth', methylated pigments, malvidin appearing first, peonidin later but more abundantly

bract. Malvidin appeared several days before peonidin, when the two, as in this experiment, were present together. This can be seen in the photograph and was proved in another experiment by two-way chromatography.

The elegant seriation of the male bud, the relatively large size of the bracts and the difference in times of appearance of different pigments all combine to indicate this as very favourable material for investigating the biosynthesis of the anthocyanins. Both the search for possible precursors[4] and the experimental approach, of supplying synthetic precursors to genetically acyanic varieties, would be feasible. Furthermore, the possibility of being able to approach the problem of methylation is particularly attractive[5].

Leucoanthocyanidins. Leucodelphinidin[6] and leucocyanidin are almost universally present in bracts, flowers, fruits, sheaths and leaves of all bananas. They are especially abundant in green fruits; the great quantities of this material available at once suggest bananas as an excellent source for structural and biochemical investigations, since quantities of the order of 5 kgm. of dried material could quite easily be obtained.

A fuller account of this work will be published elsewhere. My thanks are due to Dr. E. C. Bate-Smith, Dr. W. G. C. Forsyth and Mr. K. De Witt for much help.

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An Inhibitor of the Lysis of *Staphylococcus aureus* by Bacteriophage

Undiluted phage lysates of certain strains of *Staph. aureus* (type 75*B*) but not of others (type 69) have been shown by us to inhibit the propagation of a wide range of staphylococcal phages[1]. To throw light on the nature of this inhibitor we have carried out the following experiments.

Fresh lysates were produced by plate propagation of phage 75*B* on *Staph. aureus PS75B*, as described by Williams and Rippon[2], and filtered through 'Gradocol' membranes of pore diameter 55 mμ, 83 mμ and 140 mμ. The filtrates were spotted on a plate freshly inoculated with phage and *Staph. aureus* 31*A* as for propagation. After incubation the plates showed diffuse lysis, with disks of staphylococcal growth at the sites inoculated with filtrate from the membranes of 83 mμ and 140 mμ pore diameter, but not at the sites where filtrate through pore diameter 55 mμ had been inoculated. Lytic phage was present in filtrates from the 83 mμ and 140 mμ membranes, but none was found in the filtrate from the 55 mμ membrane. The inhibitor was therefore carried on particles of the same order of size as the phage particles.

We next compared the heat sensitivity of lytic and inhibitory components of the phage 75*B* lysate. 1-ml. amounts of the lysate were heated for 10 min. at 42°, 47° and 52° C., samples being taken at 1-min. intervals, and tested for inhibition and lysis. We found that the inhibitor was destroyed after 2 min. at 52° C., but was unaffected after 10 min. at 42° C. and 47° C. Plaque counts from the same samples titrated for viable phage showed that no significant reduction in lytic power occurred after 10 min. at 52°C.

These experiments suggest that the phage inhibitor may be carried on phage particles, but that the properties of lysis and inhibition can be dissociated by heat, the former persisting at temperatures which destroy the latter.

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Effect of Nickel Versenate on Oat Plants

Iron versenate is now being widely used for supplying iron in plant nutrition studies[1], and it seems likely that the use of versenates of essential micro-nutrients will be extended to horticultural and agricultural practice. Ferric potassium versenate has been used here for two years as a source of iron for oats, sugar beet and tomatoes, and has proved superior to ferric citrate, especially where the *p*H of the nutrient solution is greater than 6·0. It is not clear whether the complex molecule itself is absorbed or whether the iron is removed at the root surface by a contact-exchange mechanism, as has been suggested by some workers[2].

Nickel toxicity studies carried out in this department, following the discovery of several naturally occurring nickel-toxic soils in Aberdeenshire, have established that 2·5 p.p.m. nickel (as sulphate) in the

nutrient solution will produce marked necrosis in oats grown in sand culture. The form of iron supplied (versenate or citrate) has no effect on the intensity of the toxic symptoms, although an increase in iron-level reduces necrosis[3].

Soil studies had indicated that much of the nickel in a peaty nickel-toxic soil is present in chelate form, associated with the soil organic matter, and that this nickel is readily available to plants. It was therefore decided to investigate the effect of a chelate form of nickel on oats in sand culture.

Nickel versenate (1 mol. nickel to 1·5 mol. ethylene-diamine tetra-acetic acid) was supplied at a level equivalent to 2·5 p.p.m. ionic nickel in the nutrient solution. Iron was given either as versenate or citrate at 1·2 p.p.m., and plants received nutrient solution in adequate amounts twice daily from germination.

Ionic nickel produced characteristic longitudinal white striping of the oat leaves, which first appeared when plants were 5 cm. high. The plants supplied with nickel versenate were still a healthy green when the experiment was sampled at the end of thirty-five days. Plants were dried and major elements, nickel and iron, determined in the dry matter after ashing. Variation in treatment produced no significant differences in content of major elements. Average values for yield and nickel and iron contents of the two pots in each treatment are set out in the accompanying table.

	Fresh yield per pot (gm.)	p.p.m. Metal in dry matter	
		Iron	Nickel
Ferric citrate series			
Control	65·5	100	11·3
2·5 p.p.m. Ni^{2+}	56·5	104	124
2·5 p.p.m. Ni as versenate	72·9	91	9·7
Iron versenate series			
Control	67·6	107	8·4
2·5 p.p.m. Ni^{2+}	57·7	105	100
2·5 p.p.m. Ni as versenate	64·7	91	14·5

Since the level of nickel in plants supplied with nickel versenate did not vary significantly from that of the controls, whereas in plants receiving ionic nickel at the same concentration the level was more than ten times as great, the inference is that no absorption of the nickel complex occurred. For the same reason, it would appear that the plants were unable to remove nickel from the complex at the root surface, although this may well have been the mechanism operative in the case of iron.

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Rate of Milk Secretion in Dairy Cattle in the Intervals between Consecutive Milkings

With dairy cows milked by the normal methods, a proportion of the milk is not removed from the secretory tissues of the udder. This residual milk may be up to 20 per cent of the milk and contain 50 per cent of the fat present in the udder at the start of milking[1]. The amount left is proportional to the milk yield[2]. Early experiments designed to determine the rate of secretion of milk did not allow for variations in the amount of this residual milk, and it was assumed that the yield of milk obtained at a milking was a true measure of the amount secreted since the last milking. These experiments[3,4] indicated that the rate of secretion of milk and fat is inversely proportional to the time since the last milking, and that the rate of formation of the milk fat declines more quickly than the non-fatty fraction. The importance of residual milk in experiments on rate of secretion has been pointed out by Turner[5], who, after correcting for these effects, suggests that rate of milk secretion does not decline for twenty hours after the last milking. Using an experimental method designed to eliminate residual milk effects, it has been shown at this Institute that the rate of formation of milk and fat both decline with increasing interval since the last milking, and the fall in the rate of secretion of fat is not greater than that of the milk.

Experimental method. In order to eliminate the effect of residual milk the following experimental method was adopted. Five cows were milked at intervals of 3, 6, 9, 12, 15 and 18 hr., the order of milking being as follows: 12 (6), 9 (5), 15 (5), 6 (8), 18 (5), 3 (24), 18 (6), 6 (10), 15 (8), 9 (7), and 12 (6). The figures in brackets indicate the number of consecutive milkings carried out for each interval. This method differed from that of the earlier workers in that five or more consecutive milkings were carried out for each of the milking intervals.

Results. The individual milk-yields in each series of milkings were similar, and it follows that the amounts of residual milk left after each milking in a series were also similar. Therefore, the milk obtained at each of these milkings can be regarded as the quantity secreted in the previous milking interval, provided that the initial milkings after each change-over are not considered.

Fig. 1 illustrates the average amount of milk secreted after the various intervals and the fat percentages of the milk calculated from the results for the five cows. In the case of the graph of fat percentage, the results are shown in two ways. Curve *B* is the graph obtained by using a mean of the consecu-

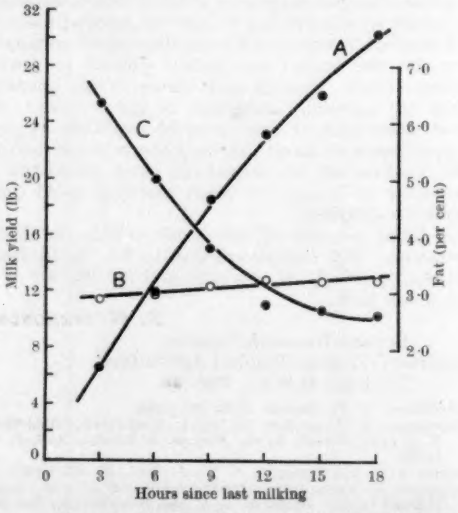

Fig. 1. The mean yield (*A*) and fat percentage (*B*) of the milk secreted by five cows in the first 18 hr. after the last milking; (*C*) shows the fat percentage of the milk obtained when no attempt is made to standardize the previous milking interval

tive milkings disregarding at least the first two readings after change-over, and curve *C* is obtained when only the first reading after each change-over is used. The results used in the latter graph are those influenced by residual milk effects, and they have been calculated by a method which approximates to that used by earlier workers[3,4].

From curves *A* and *B* it will be seen that the true rate of secretion of both milk and fat declines with increasing interval since the last milking. The milk-yield result is in agreement with Ragsdale *et al.*[3] and Johansson[4], but not Turner[5]. Curve *B* illustrates that the rate of decline of the fat secretion is not greater than the decline in milk secretion. In fact, the reverse is probably true, because the mean fat percentages of the milk secreted in 3, 6, 9, 12, 15 and 18 hr. are 2·86, 3·02, 3·19, 3·17, 3·20 and 3·24 per cent respectively. The results illustrated by curve *C* are influenced by residual milk and show a similar trend to those of Ragsdale *et al.*[3] and Johansson[4].

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Low Niacin Concentration in the Breast Milk of Bantu Mothers on a High-Maize Diet

Goldsmith and co-workers[1] prepared wheat and maize diets containing equal, though relatively small, amounts of niacin and tryptophan, 4·7 and 190 mgm. per diem respectively; when fed to human subjects, only those consuming the maize diet developed pellagra. In view of this abnormality of metabolism on the maize diet, it has been considered worth while to investigate whether a diet containing this cereal causes any abnormality in the concentrations of niacin and tryptophan in breast milk. Available information suggests that the level of niacin in the breast milk of White mothers is relatively independent of dietary intake[2]. In South Africa, however, Kropman[3] found twelve Bantu breast milks to contain an average of 108 μgm. niacin per 100 ml.; this average is low in comparison with the mean value of 183 μgm. obtained for the milks of 268 American mothers[4]. Kropman[3], unfortunately, provided no dietary information on the mothers concerned—an important point in the present issue, since the consumption of maize by the Bantu varies enormously, one report giving a range of 6–20 oz. per diem for urban dwellers[5].

To throw light on the subject, breast milks from four groups of mothers have been investigated: (1) Urban Bantu mothers in poor circumstances whose consumption of maize meal (90–100 per cent extraction) exceeded 1 lb. per diem, and supplied 65–85 per cent of total calories; (2) Indian and Eurafrican mothers consuming a small though variable amount of maize; (3) Bantu and Indian mothers accustomed to an almost Europeanized diet; (4) European mothers in comfortable circumstances who served as controls. Milk from groups 1–3 mothers were obtained, mainly from 10.30 a.m. to noon, when subjects were attending clinics for routine examination of their infants or themselves. All collections were 'spot' samples. Nevertheless, self-demand feeding is the rule among non-White mothers, that is, differences in composition between 'fore' and 'hind' milks are thereby minimized. Niacin was determined microbiologically by the method described by Gyorgy[6]. Tryptophan determinations were carried out—on milks from groups 1 and 4 mothers only—by the microbiological method of Greene and Black[7]. Estimations of intakes of niacin and tryptophan were calculated, using local[8] and American[9] food tables respectively, from dietary information collected by our dietitian, Miss J. L. Seward. These data, together with results of the determinations of these nutrients in the breast milks, are given in the table.

Intakes and Breast Milk Concentrations of Niacin and Tryptophan of Bantu and Other Mothers

Group of mothers	Niacin		Tryptophan	
	Intake (mgm./diem)	Breast milk (μgm./100 ml.)	Intake (mgm./diem)	Breast milk (mgm./100 ml.)
1. Bantu (high-maize diet)	15–18	70±51 (38)* (15–140)	550–850	23±6 (18)* (11–33)
2. Indian and Eurafrican	not estimated	105±45 (15)* (50–175)	not estimated	not estimated
3. Bantu and Indian (Europeanized diet)	not estimated	150±52 (8)* (85–270)	not estimated	not estimated
4. European	9·5–15	175±48 (8)* (110–295)	1,100–1,400	21±4·5 (12)* (13–29)

* Number of milks examined.

Digestion of group 1 breast milks with *N* sodium hydroxide for 10 min. at room temperature caused no increase in niacin concentration; hence, the vitamin is present wholly in 'unbound' or available form[10]. The difference between the means of the niacin concentrations in groups 3 and 4 mothers is not significant; in this respect, therefore, the racial factor is unimportant.

The salient observation is that, despite a probably higher intake of total niacin, the mean niacin concentration in breast milk of the high-maize Bantu mothers is much lower than the mean value for the combined groups 3 and 4 mothers consuming the European diet. The difference is statistically highly significant ($P < 0{\cdot}001$). Calculation reveals the loss of niacin in the breast milk to be small in comparison with total niacin intake—approximately 5 per cent for group 1 mothers at the third month of lactation.

Considering the results as a whole: first, wide variations of niacin concentration occur within groups, as with other constituents[11]; secondly, mean niacin concentrations increase with decreasing maize consumption. Obviously, it would be erroneous to interpret differences in niacin concentration in terms of maize intake only. However, it would seem reasonable to regard the unusually low concentration of the vitamin in Bantu breast milk as reflecting a further abnormality of niacin metabolism under conditions of high maize intake. Whether the abnormality is due to a large proportion of ingested niacin being 'bound', or to suppression of intestinal

biosynthesis of the vitamin, or to other causes, requires further investigation.

The low intake of niacin by Bantu breast-fed babies is not apparently deleterious, for local pediatricians aver that there is parity of growth and general health between Bantu and European babies when exclusively breast-fed up to six months.

There is no statistical difference between the mean concentrations of tryptophan in the breast milks of the Bantu and European mothers (groups 1 and 4).

The determinations of niacin and tryptophan were carried out by Mr. G. Smith and Miss H. S. P. Snyman, of the South African Bureau of Standards, Pretoria. This communication is published with the permission of the South African Council for Scientific and Industrial Research.

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Formation of Enzymatically Active, Dialysable Fragments during Autodigestion of Pepsin

Northrop and co-workers have shown[1] that pepsin in solution digests itself with the formation of material soluble in trichloroacetic acid. The amount of non-protein substance formed depends upon factors such as time, temperature, and the *p*H and composition of the solvent. It has now been found in this laboratory that if autodigestion of pepsin proceeds at *p*H values removed from those optimal for proteolysis, *p*H 1·5–2·0, activity can be recovered in the non-protein fraction.

In a typical experiment, 0·6 gm. Worthington crystalline pepsin is dissolved in 60 ml. 0·1 *M* sodium acetate buffer of *p*H 5·6. The solution is then incubated at 37° C. and 10-ml. samples are withdrawn at intervals of 12, 18, 24, 30, 36 and 48 hr. and quickly chilled to 5° C. A portion of each sample is next dialysed at the low temperature for 24 hr., against 2·5 volumes of the acetate buffer. With the aid of the hæmoglobin method[2], the activities of the protein, both before and after dialysis, and of the dialysate are determined. Enzymatically active fragments are found in the dialysate after incubation at 37° C. for 24–48 hr. This material represents 10–20 per cent of the total protein and has an activity, per unit of nitrogen, of 1–5 per cent relative to that of the intact enzyme. The dialysable material is inactivated on heating to 100° C. for five minutes or on prolonged incubation at 37° C. After passage of the hydrolysate through a column of 4 per cent cross-linked 'Dowex 50', at least two active components are isolated from the eluate. Similar results have been obtained with five crystalline preparations of pepsin, although the amount of active dialysable material found on incubation varies somewhat with the length of storage of the crystalline enzyme. In all these experiments, tests for bacterial contamination were made in order to eliminate this as a source of activity.

Table 1. Activity of Pepsin and its Autodigestion Products on Hæmoglobin and Acetyl-1-phenylalanyldiiodotyrosine

Preparation	Time of incubation at 37° C. (hr.)	mgm. Nitrogen per ml. of solution	Relative specific proteolytic activity per unit nitrogen*	
			Hæmoglobin	Synthetic substrate
Pepsin, control	0	1·35	100	100
Pepsin	9	1·32	96	not tested
Pepsin, dialysed		1·28	110	not tested
Dialysate		0·1†	0	0
Pepsin	48	1·34	97	95
Pepsin, dialysed		1·16	92	100
Dialysate		0·2†	3	64

* The relative specific activity of a freshly prepared dialysed enzyme solution is taken as 100.
† Nitrogen values of the dialysate refer to 1 ml. of the original protein solution.

Although, as indicated with a typical experiment listed in Table 1, the activity of the dialysable fraction against hæmoglobin is low, that against the synthetic substrate acetyl-1-phenylalanyldiiodotyrosine[3] is 64 per cent of the value for the intact protein. It thus seems reasonable to suppose that the active fragments may represent a portion of the original protein with an amino-acid configuration specific for the hydrolysis of a peptide bond adjacent to a tyrosine residue[4]. In contrast, the low activity against the protein substrate may be taken as an indication that proteolysis of hæmoglobin involves a variety of types of bonds, for some of which the dialysable fragment has a reduced activity.

I wish to thank Dr. Lillian E. Baker for a generous sample of acetyl-1-phenylalanyldiiodotyrosine and Dr. Lewis G. Longsworth for suggestions during preparation of the manuscript.

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Effect of Temperature on Leaf-shape in *Ranunculus*

In trifoliate species of *Ranunculus* the first-formed and juvenile leaves are undivided, and as the plants mature the adult trifoliate or biternate condition is gradually taken up by new leaves. Quite frequently, however, some of the later leaves of mature plants show a partial reversion to a less divided, more juvenile form. This reversion may occur in leaves of similar age in many plants in a single area, which suggests a temporary or seasonal environmental cause.

An investigation has recently been carried out to determine the separate effects upon leaf-dissection

of differences in humidity, light-intensity and temperature. Using a pair of controlled-environment cabinets[1] it has been possible to grow plants for extended periods varying only one of the three major environmental factors at a time. Batches of twenty-seven adult plants of *Ranunculus hirtus* B. and S., a trifoliate species of forests in Australia and New Zealand, were grown for three months under each set of conditions. Illumination throughout was provided by Philips warm-white fluorescent tubes with a fourteen-hour day. The conditions that were applied are shown in the accompanying table.

Batch		Humidity (rel. per cent)	Light intensity (foot-candles)	Temp. (° C.) Day	Night
1	*A*	95–98	400	15	10
	B	45–50			
2	*A*	90–94	200	15	10
	B		800		
3	*A*	90–94	400	10	5
	B			20	15

Although marked differences in size, habit and root-shoot ratio developed between the *A* and *B* batches of the first two experiments, no differences in leaf-dissection were produced. In the third experiment, however, marked differences in leaf-dissection were produced under different temperatures. Under the higher temperature there was a complete reversion to an undivided juvenile leaf-form in all leaves opening after six weeks from the start of the experiment. Under the cooler conditions the leaves kept their adult trifoliate form.

The reversion effect produced by the higher temperature persisted in new leaves for a further two months after the plants were replaced in the open at the end of the experiment. Subsequent leaves reverted to the original adult state.

This investigation has been carried out with the assistance of a Biological Research Grant and maintenance allowance from the Nuffield Foundation. A full account of this work will be published elsewhere.

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Dec. 23.

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Anatomy of Roots and Shoots of *Brassica campestris* L. in Relation to Vernalization

The present communication summarizes the results of a further study[1] of the comparative anatomy of plants raised from vernalized and normal seeds of mustard. The technique used for radicles, shoot apices and stems fifteen days old has been described elsewhere[1,2]. Stems at the ages of 37, 45 and 56 days, using the method of Wilton and Roberts[3], were fixed in formalin-aceto-alcohol, passed through the *n*-butanol series, embedded in paraffin, sectioned 15–18 μ thick and stained with erythrosin and crystal violet.

Radicle. The structure of the normal radicle and its vascular differentiation have already been described[4]. The following table presents a comparative study which shows that there is earlier initiation of differentiation of vascular elements in vernalized radicles.

Nature of seeds	Treatment	Condition of vascular elements at each pole: Protophloem	Protoxylem
Unsplit	Normal	No differentiation	No differentiation
,,	Vernalized	One differentiated element	One differentiated element
Just split	Normal	,,	One at various stages of differentiation
,, ,,	Vernalized	1–2 differentiated elements	2–3 differentiated elements

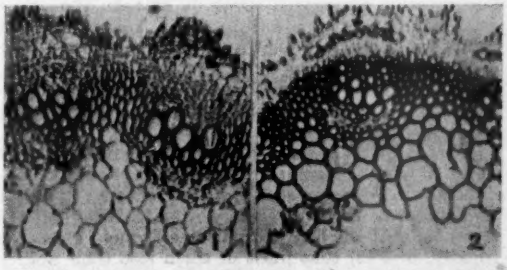
Shoot apices. A search for differentiated protoxylem elements in the median traces of the various leaves on the shoot apices of plants 15 days old showed that in all the five plants obtained from treated seeds, the median trace of the fourth leaf from the apex has either a mature, an immature, or both types of xylem elements, while in the corresponding controls only two plants out of seven show this feature. Thus, in vernalized plants comparatively younger leaves have xylem elements differentiated first.

In the 15-day old sample, out of eight vernalized and seven control shoots examined, six apices of the former possess three layers of tunica and only two of the latter. Thus, the advanced stage of development marked by three-layered condition of the tunica[2] is reached earlier in the vernalized material. A week later the apices of the treated plants have all the characteristics of a reproductive shoot[2], whereas those of the untreated plants possess a three-layered tunica, the cells of which are approaching a columnar condition.

Stem. In the case of 15-day old material, scarcely any difference could be observed between the treated and normal ones, and there is vigorous cambial activity in both which starts in seedlings three to four days old. In the second sample (37 days old), the vernalized plants possess a pericyclic zone the cells of which could be distinguished from the cortical ones whereas in the control plants they could not. The former also possess thicker-walled medullary ray cells and comparatively smaller vessel elements in the xylem, which is formed last.

In the sample collected at an age of forty-five days, besides the above-mentioned conditions, there is a greater thickening of the walls of the cells in the perimedullary zone of the vernalized plants. The cells in the bundle caps, medullary rays and perimedullary zone of the treated plants fifty-six days old are thicker-walled and they stain with crystal violet, as opposed to those of normal stems (Figs. 1 and 2). Again, the walls of the phloem cells in the vernalized plants are slightly thickened and more compressed, and there are few vessels in the latest formed xylem.

Thimann[5] suggested that early flowering might result from the differences in the supply system and,



Figs. 1 and 2. Transverse section, second elongated internode below the terminal inflorescence of 56-day old control and vernalized plants of mustard, respectively. Arrow indicates bundle cap. × 100

therefore, in the materials made available to the developing initials. Earlier differentiation of the vascular elements in vernalized mustard indicates that this is a possibility. A direct relationship between the flowering impulse and the activity of the cambium has been recorded by several workers[6]. Struckmeyer[7] even observed a decrease in the activity of the cambium in plants within a short period of their subjection to photoperiods suitable for flowering. In the present case, however, no such abrupt change could be detected, and all the treated plants possessed a normally developed cambium, indicating thereby that the substance or substances formed during chilling are not direct flower-forming substances and thus differ from those synthesized in the leaves[8] during photoperiodic treatment. Similar conclusions have also been arrived at by several workers with cereals[8], although the substance or substances formed in mustard seeds during chilling differ from those in cereals in certain respects[1].

A detailed account of the comparative anatomy of mustard and several other plants will appear in the *Indian Journal of Agricultural Science*.

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Long-Term Adaptation to the Fermentation of Galactose in *Saccharomyces chevalieri*

The dominant gene, controlling the adaptive fermentation of galactose, and the recessive gene, carried by the Carbondale stocks of *Saccharomyces* incapable of fermenting galactose, comprise a pair of extraordinarily stable and well-defined alleles. The non-fermenters of the Carbondale stock contain no detectable galactozymase and are incapable of fermenting galactose. Exceptional cultures called 'long-term' fermenters of galactose ferment galactose on duplicate tests after irregular periods of 4–30 days, while the corresponding stocks carrying the dominant allele cause fermentation within 48 hours. Mundkur and Lindegren[1] mated rapid-fermenter mutants isolated from 'long-term' fermenters with non-fermenters and found that the capacity for rapid fermentation segregated regularly at reduction, thus establishing the genic nature of the adaptation and the basis for the view that in the long-term fermenter a change occurs from non-fermenter to fermenter. The rapid fermentative character was retained by the original mutant and the segregant offspring after serial transfer on glucose.

Saccharomyces chevalieri is a 'long-term' fermenter different from the long-term fermenters of the Carbondale stock. Winge and Roberts[2] showed (1) that fermentation occurs regularly after a delay of 4–8 days, (2) that the adapted cultures ferment galactose rapidly, and (3) that most of them lose their ability to ferment galactose rapidly, that is, become 'de-adapted' after growth on glucose or maltose. They proposed that adaptation and de-adaptation involved the entire population. Spiegelman, De Lorenzo and Campbell[3] showed that the capacity for rapid fermentation is distributed discontinuously among the members of the rapidly fermenting culture. Mundkur[4] found that matings between the rapid fermenters isolated from *S. chevalieri* and non-fermenter cultures of the Carbondale stocks produced hybrids in which the character for rapid fermentation segregated at reduction, proving that the change from non-fermenter to fermenter in *S. chevalieri* occurred as the result of mutation and selection of the mutant in the presence of galactose. He also indicated that the gene controlling rapid fermentation undergoes reverse mutation.

Nearly all *Saccharomyces* cultures produce variable numbers (1–10 per cent) of small smooth colonies which stand out in sharp contrast to the normal larger colonies on an agar plate. It was shown by Lindegren and Lindegren[5] that most of the extensive morphological variation characteristic of *Saccharomyces* haploids arises from the small smooth colonies. Ephrussi[6] found that the numbers of small smooth (petite) colonies can be increased by exposure to acriflavine and that both the spontaneous and the induced petites are deficient in cytochrome. *S. chevalieri* resembles other *Saccharomyces* in producing petite colonies which do not consume oxygen or utilize lactate[7]. Direct observation of budding has revealed that mitochondria are distributed to the bud at random and that some buds may receive only a single mitochondrion[8], thus supplying the possible mechanism for the loss of cytochrome and the origin of petites. When petite colonies of *S. chevalieri* are plated on eosin – methylene blue galactose-agar containing peptone and yeast extract, the discontinuous nature of the transformation from non-fermenter to fermenter of galactose can be observed. By the seventh day nearly two-thirds of the colonies contain one or more red papillæ. Subcultures isolated from the red papillæ ferment galactose rapidly (within two days) and do not become de-adapted after serial transfer on glucose. These rapid fermenters of galactose retain the characteristic small size of petites and are respiratory-deficient, being unable to consume oxygen with either glucose or galactose as the substrate. The large colonies also produce normal papillæ on *EMB* agar which overgrow the colonies by the fifth and sixth days. On the basis of Mundkur's findings[4], it seems obvious that the discontinuous origin of the stable fermenters is by gene mutation.

Deliberate mixtures of the petite fermenter and the normal unadapted type were grown in glucose broth and on glucose-agar plates. In both cases the respiratory-sufficient normal strain overgrew the petite fermenter and the culture became 'de-adapted' to a long-term fermenter. Small numbers of stable rapid fermenters of the normal type in deliberate mixtures are inhibited by the presence of the normal unadapted strain when the two are planted in defined galactose agar. This phenomenon explains certain discrepancies encountered in fluctuation tests and validates the variance method in yeast genetics. It is inferred (1) that fermentation of galactose by *S. chevalieri* is due in part to mutation of a gene controlling galactose fermentation, and (2) that the fermenting culture is a mixture in which (3) de-adaptation is achieved by reversion to the non-fermenter type on transfer to glucose. The evidence presented above shows that a major mechanism in 'long-term' adaptation is mutation and selection, complicated by suppression; but, specific

DIFFERENTIAL BEHAVIOUR OF *Saccharomyces chevalieri* AND ITS PETITE VARIANT IN ADAPTATION TO GALACTOSE

Classification of colonies	Respiratory activity of cells	Adaptation to galactose in fermentation tubes (*defined medium*)	Fermenter papillæ on colonies grown on *EMB* complete galactose agar	Characteristics of rapid fermenters of galactose
Normal (large)	Respiratory-sufficient; utilize lactate; consume oxygen	Fermentation completed in all tubes in 5–7 days	100 per cent of colonies contain one or more papillæ by 3rd or 4th day; overgrown by 5th and 6th days	Normal (large colonies) respiratory-sufficient, rapid (two-day) fermenters of galactose; may become de-adapted
Petite (small)	Respiratory-deficient; cannot utilize lactate; do not consume oxygen	Fermentation irregular; completed in 9–18 days	Less than 1 per cent of the colonies contain papillæ by 3rd or 4th day; 64 per cent of colonies contain one or more papillæ on 7th day	Small colonies, respiratory-deficient, rapid (two-day) fermenters of galactose; do not become de-adapted

experiments were not devised which would exclude the possibility that mechanisms involving cytoplasmic particles or slow genes may co-exist. Most of the normal rapid fermenters of galactose yield de-adapted populations after growth on a galactose-free substrate. Some of the petite rapid fermenters derived from the de-adaptable respiratory-sufficient fermenters also become de-adapted. These data are consistent with the views that an extra chromosomal apparatus may be involved[2,9]; the possibility that two mechanisms may operate simultaneously in adapting populations warrants serious consideration in formulating a concept of microbial adaptation.

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Identification of the Genes for Maltose Fermentation in *Saccharomyces diastaticus*

Winge and Roberts[1] have established that *Saccharomyces cerevisiae* contains three polymeric genes for maltose fermentation, M_1, M_2 and M_3, and they have obtained by mutation a fourth maltase gene (M_4).

It has been found[2] that *Saccharomyces diastaticus* contains two maltase genes, one governing normal fast fermentation (M_F) and one governing slow or delayed fermentation of maltose (M_S).

Prof. Ø. Winge has very kindly made available four hybrid yeasts each of which is homozygous for one of the genes M_1, M_2, M_3 or M_4. These yeasts were crossed, by Winge's spore-to-spore method, with cultures which were homozygous for M_F or M_S alone. Four-spored asci of the hybrids thus obtained were analysed for the segregation of maltose fermentation with the results shown in the accompanying table.

Crossing	Number of 4-spored asci of the hybrid giving segregation of maltose fermentation 4+:0−	3+:1−	2+:2−	Probability of this distribution if the two genes are non-allelic	allelic
$M_F \times M_1$	6	0	0	0·00002	1
$M_F \times M_2$	2	3	1	0·08	0
$M_F \times M_3$	0	5	1	0·13	0
$M_F \times M_4$	1	4	1	0·16	0
$M_S \times M_1$	0	5	1	0·13	0
$M_S \times M_2$	0	6	0	0·09	0
$M_S \times M_3$	2	3	1	0·08	0
$M_S \times M_4$	1	3	2	0·08	0
Theoretical 2-gene segregation	1	4	1		

It is thus established that the M_F gene of *S. diastaticus* is M_1. It is also established that the M_S gene of *S. diastaticus* does not correspond with any of the four genes M_1, M_2, M_3 or M_4, and it may be called M_5.

The maltase gene in *Saccharomyces italicus* was also identified[3] as M_1, so that this gene is common to all the naturally occurring maltose-fermenting yeasts so far examined.

The Directors of Messrs. Arthur Guinness Son and Co., Ltd., have granted permission for the publication of this work.

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Environmental Influences and the Maxillary Index in *Anopheles gambiae*

APPARENTLY contradictory reports of the behaviour of *Anopheles gambiae* in different parts of Africa have led to suggestions that more than one biological race of this species exists. In French West Africa, Holstein[1] has attempted to correlate these differences with variation in the maxillary index—the number of teeth on both maxillæ, divided by two. He has recognized a paucidentate population with a maxillary index of 13·5 and a multidentate population with an index of 15. The former is said to be anthropophilic, mainly exophilic and to breed for preference in temporary pools in which the organic content of the water is low; the latter to be zoophilic, endophilic and to breed in permanent types of water of high organic content. Holstein has stated unequivocally that these two populations represent distinct biological races, and in this he has been supported by

Campbell[2], working in Gambia, who was able to confirm the difference in maxillary counts in females emerging from different breeding sites.

These conclusions are of considerable epidemiological and practical importance; but up to now it seems that critical attention has not been paid to the possibility that some of this morphological variation might be due to environmental influences. To explore this possibility the following experiment was carried out.

Individual egg batches were obtained from wild-caught *A. gambiae* from Muheza in Tanganyika. Each batch was divided into two parts, which were reared separately, with the object of finding a combination of breeding conditions that might have a maximum effect on the maxillæ. One part was reared at a thermostatically controlled temperature of 32·2° C., the other at room temperature, which fluctuated around a mean of 21·1°. As it was found that overcrowding influenced both the maxillary counts and wing-length, an average of 100–150 eggs was put into the hot bowls, and, with the exception of the first experiment, 300–450 into the cool bowls. Thus 400–600 eggs were used in each experiment, the number of eggs taken from each batch depending on the number of batches available. Eggs were transferred to the appropriate bowls (12 in. × 10 in.) some 12–36 hr. after deposition; pupæ were reared in separate containers but at the same temperature as their respective larvæ. All larvæ were fed on a suspension of a commercial preparation of yeast ('Perolin'). Little difficulty was encountered with feeding, although there was a considerable mortality among the later instar larvæ in the crowded bowls.

The results of six experiments on these two genetically identical groups, shown in Table 1, gave striking evidence of the wide variation in maxillary index that could be induced by simple alteration of the larval environment. It appeared also that growth of the maxillæ was not obviously related to linear growth as measured by wing-length (parents, 2·9 ± 0·06 mm.; hot bowls, 2·72 ± 0·06 mm.; cool bowls, 3·12 ± 0·06 mm.).

Table 1. Maxillary Index of *A. gambiae* reared under Different Laboratory Conditions. Six Experiments

Parents wild-caught		Progeny hot, uncrowded bowls		Progeny cool, crowded bowls	
No.	Max. index	No.	Max. index	No.	Max. index
3	14·8	30	15·7	26	15·2
14	14·2	22	16	59	14·1
16	14·3	50	15·4	39	13·8
20	14·5	35	16·1	21	14·6
5	15·5	52	16	35	14·4
5	14·6	37	15·9	32	14
63	14·5±0·6	226	15·8±0·3	212	14·3±0·3
Egg-adult period		8·5 days		15·5 days	

This work makes it clear that, unless adults are reared under standard conditions, no valid comparisons can be made of the maxillary indices of populations derived from different localities or breeding sites. On these grounds, the conclusion of Holstein and Campbell, that the differences between the two populations of *A. gambiae* that they studied were genetically determined, cannot be accepted as it stands; nor can the possibility be ruled out that much of this variation was phenotypical.

While differences of a geographical nature may, and probably do, exist, it must be concluded that there is no convincing evidence available at present that points to the co-existence in the same region of biological races of this species.

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Failure to Publish Scientific Results

I wish to direct attention to the large amount of scientific work carried out at the public expense but only reported in brief summary terms or published after long delay. This may be due in part to habits acquired in war-time, when the scientist was too busy to prepare papers for publication and the journals so restricted that they could not accept them. It is due also to the dangerous custom of writing a number of progress reports which are circulated within groups of Government committees in stencil: the authors frequently do not face the labour of preparing a paper of the type which a conscientious editor would accept.

It seems that an example is furnished by some of the work carried out under the Colonial Research Council*. Under that Council is a committee dealing with insecticides which met first in January 1947. Since the report for 1948–49, that Committee has referred each year to experiments being done with insecticidal sprays from the air in East Africa. It is evident from the page or so published that the investigation is well staffed (indeed in the last year the staff consisted of "4 entomologists, a physicist, a chemist, a senior executive officer and 9 European assistants"); it also appears to be well planned: one notes that there is a careful estimation both of the insecticide that reaches the ground and of the insect populations which are the target. The group of workers carrying this out appear to have published no scientific papers until the end of 1953[1,2]. These papers apparently deal with experiments carried out so long ago as March 1948.

It seems probable that the work done by this group in East Africa is more full and careful than that performed by any other country; but if one wishes to know about insect destruction by aerial spray, one must use the other people's work because it is available.

This British work on insecticides is lavishly financed and has received 7·5 per cent of the £12,000,000 allocated to the Colonial Research Council up to 1953, namely, £900,000. As most of the work carried out by the Insecticide Committee appears not to be very expensive, we conclude that the air spraying has cost about three-quarters of a million pounds. It is difficult to see why work should be done and paid for, if it is not made available or if it is to be published after it is out of date.

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* See p. 374 of this issue of *Nature*.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 1

ROYAL SOCIETY OF EDINBURGH (at 24 George Street, Edinburgh), at 4.30 p.m.—Prof. James Kendall, F.R.S.: "Humphry Davy and his Connections with Scotland".

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. R. Young: "Progress in Petroleum Refining".

UNIVERSITY OF LONDON (in the Physics Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. E. Marshak (Rochester, U.S.A.): "Scattering of Mesons by Nucleons". March 3: "Nucleon-Nucleon Scattering at High Energies". March 5: "New Unstable Particles".*

UNIVERSITY OF LONDON (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 5.30 p.m.—Prof. O. W. Tiegs, F.R.S. (Melbourne): "The Flight Muscles of Insects".* (Further Lectures on March 2 and 3.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.45 p.m.—Annual General Meeting.

Tuesday, March 2

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "Petrie and his Egyptological Collection".*

INSTITUTION OF CHEMICAL ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. Hoog: "The Importance of Chemical Engineering Studies in Relation to Process Development".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Sir Lawrence Bragg, F.R.S.: "X-Ray Optics". (Further Lectures on March 9 and 16.)

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. F. Tyson: "Metal Sandwich Construction".

SOCIETY FOR VISITING SCIENTISTS LTD. (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Science of Clothing".

Wednesday, March 3

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. G. P. Wibberley: "The Challenge of Rural Land Losses".

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Meeting Room of the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting; Dr. E. B. Hughes: "The Contribution of Public Analysts and Other Analytical Chemists to Public Welfare" (Bernard Dyer Memorial Lecture).

Thursday, March 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 3 p.m.—Dr. Irving P. Krick: "Weather Modification and its Value to Agriculture and Water Supply".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. A. Hall, F.R.S.: "The Work of the Royal Aircraft Establishment".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. G. M. Bull: "Regulation of Body Water".* (Last of fifteen Lectures on "The Scientific Basis of Medicine".)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Sir Harold Spencer Jones, F.R.S.: "Changes in the Rotation of the Earth". (Further lectures on March 11 and 18.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. J. P. Dennison: "High Temperature Corrosion".

ROYAL AERONAUTICAL SOCIETY (at the Royal Fort Physics Laboratory, Bristol), at 7 p.m.—Major G. P. Bulman, C.B.E.: First Barnwell Memorial Lecture.

UNIVERSITY OF LONDON (at Wye College, Near Ashford, Kent), at 8.15 p.m.—Prof. P. B. Medawar: "Some Problems of Individuality in Cattle, Mice and Men".*

Friday, March 5

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the CORROSION GROUP and the GLASGOW SECTION, in the Royal Technical College, George Street, Glasgow), at 2.30 p.m. and 7.15 p.m.—Scientific Papers.

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. Pickthall: "Talking of Perfumes".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. H. Munro Fox, F.R.S.: "Oxygen and Life".

Saturday, March 6

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. Norman Cook: "Roman London".*

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. N. R. Nicoll: "The Design of a Life Compartment Necessary for Space Travel".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (March 6).

PRINCIPAL OF ERITH TECHNICAL COLLEGE—The Clerk to the Governors, 11 Essex Road, Dartford, Kent (March 6).

RESEARCH ASSISTANTS (3) (graduates, preferably in economics, agricultural economics, agriculture or geography) IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS—The Registrar, Wye College, near Ashford, Kent (March 6).

SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry, geology or geography) IN THE DEPARTMENT OF PEDOLOGY, Soil Survey (Scotland) Section—The Secretary, The Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (March 6).

HOSPITAL PHYSICIST (basic grade) IN THE PHYSICS DEPARTMENT—The Secretary, Board of Governors, Hammersmith Hospital and Postgraduate Medical School, Du Cane Road, London, W.12 (March 9).

ASSISTANT LECTURERS (with special qualifications in physical chemistry, and for one post preferably with experience in surface chemistry) IN CHEMISTRY—The Registrar, The University, Manchester (March 12).

PARASITOLOGIST (with a degree in veterinary science, agricultural science or zoology) IN THE DEPARTMENT OF AGRICULTURE—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. 3/4/32 (March 13).

SENIOR PHYSICIST (with honours degree and at least five years experience in hospital physics or related research, and preferably with a practical knowledge of radio-elements)—The Group Secretary, Northern Group Hospital Management Committee, Royal Northern Hospital, Holloway, London, N.7 (March 13).

STAFF TUTOR IN SCIENCE (Physics or Chemistry) IN THE DEPARTMENT OF ADULT EDUCATION, to conduct University Tutorial or Sessional Classes, to advise part-time tutors and to foster and organize the demand for scientific studies—The Registrar and Secretary, The University, Bristol 8 (March 13).

BIOLOGIST (with a university degree or equivalent qualification and some experience in freshwater biology)—The Borough Engineer and Surveyor, The Council House, Derby (March 15).

DEMONSTRATOR (graduate, with qualifications or special interest in either mineralogy and petrology or palæontology and stratigraphy) IN GEOLOGY—The Professor of Geology, University College, Keele, Staffs (March 15).

J. H. ANDREW RESEARCH FELLOW (with some research experience) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Sheffield (March 15).

LECTURER IN INORGANIC CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (March 15).

SENIOR LECTURER OR LECTURER IN BIOLOGY, LECTURERS IN CHEMISTRY, PHYSICS, ZOOLOGY AND MATHEMATICS, at the Nigerian College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (March 15).

ASSISTANT CURATOR at the Coryndon Memorial Museum, Nairobi, Kenya—The Curator, Coryndon Museum, Box 658, Nairobi (March 20).

PRINCIPAL RESEARCH OFFICER OR SENIOR RESEARCH OFFICER (with university honours degree in science, including advanced training in chemistry and botany, and preferably with research experience in the field of cell anatomy or cell physiology of plants) in the Commonwealth Scientific and Industrial Research Organization, Commonwealth Research Station, Merbein, Victoria, to investigate the dipping, drying and processing of vine fruits, including studies of the chemical, physical and physiological processes involved—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 490/40 (March 20).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (March 22).

DAIRY OFFICER (with a degree in dairying, or an equivalent university degree with dairying qualifications) in the Department of Agriculture, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (March 25).

SENIOR RESEARCH OFFICER OR PRINCIPAL RESEARCH OFFICER (with university honours degree and special training and research experience in fuel technology or in applied chemistry, or equivalent qualifications) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, in connexion with a comprehensive survey of the chemical and physical properties of Australian coals, to be responsible for the Section's work dealing with either (*a*) the carbonizing of coals, and to undertake investigations, including pilot scale studies, of their coke and gas making properties, or (*b*) the cleaning and preparation of coals, and to undertake investigations into their drying, screening and washability characteristics—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting A.480/107 (March 29).

DIRECTOR (with high qualifications in one of the sciences bearing on animal health, and considerable research and administrative experience) OF MOREDUN INSTITUTE—The Secretary, Animal Diseases Research Association, Moredun Institute, Gilmerton, Edinburgh (March 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 31).

LECTURER IN STATISTICS IN THE DEPARTMENT OF MATHEMATICS, University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, March 31).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, University College London, Gower Street, London, W.C.1 (March 31).